

China's Gasoline Demand Growth: Is Recent Deceleration Near-Term Noise or Early Stages of a Structural Shift?



Gabriel Collins, J.D.
Baker Botts Fellow for Energy & Environmental Regulatory Affairs
Baker Institute for Public Policy, Rice University
gabe.collins@rice.edu

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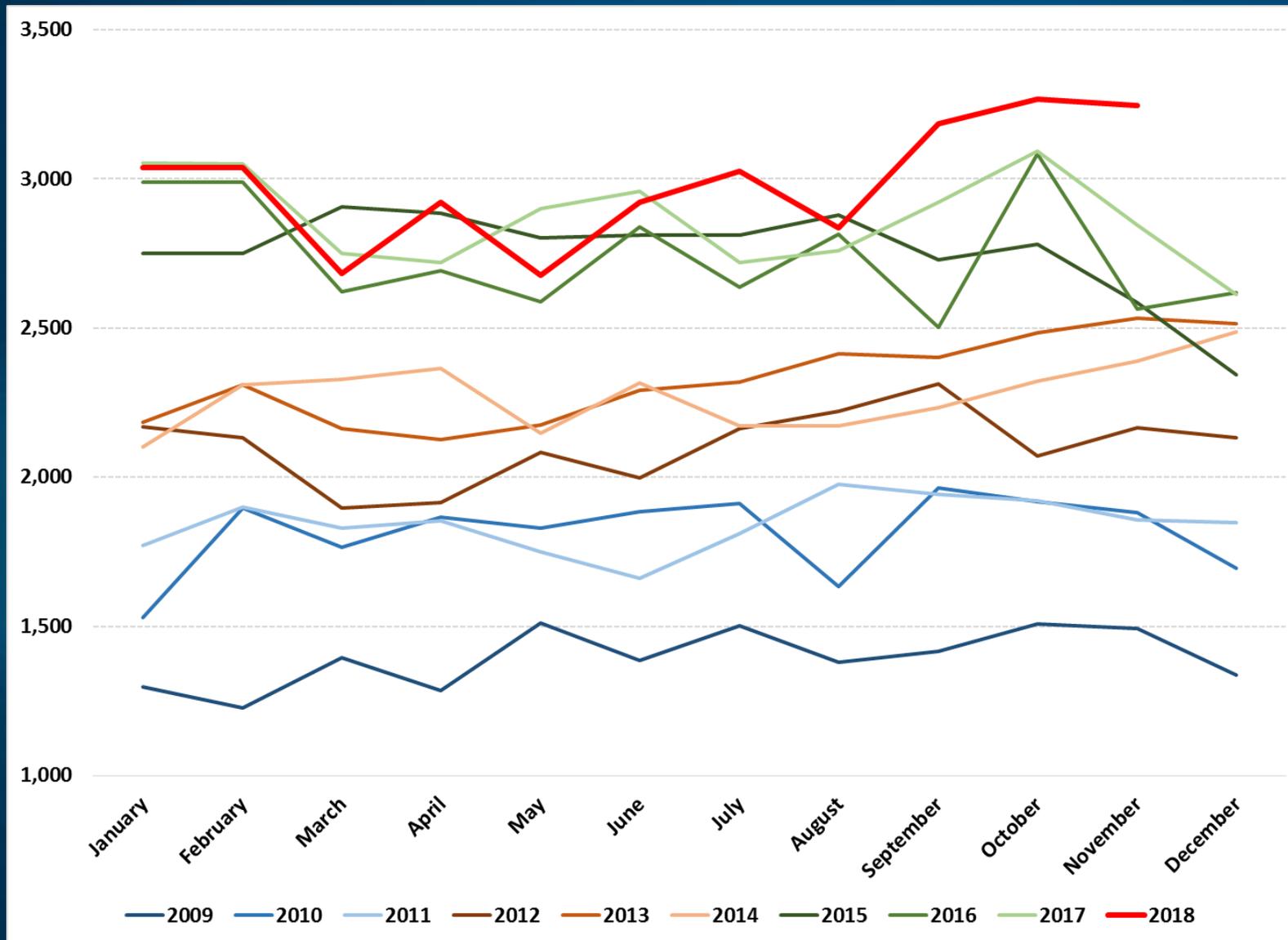
Executive Summary

- China's gasoline demand growth rate has slowed markedly in the past 3 years despite continued robust car fleet growth and appears likely to plateau sooner than expected—perhaps within the next 2-3 years.
- The core story is not about gasoline demand growth being “rolled back”—rather, it is about a contest between drivers' desires and local and national level policy imperatives.
- Several potential high-level explanations co-exist: (1) incremental gasoline demand growth potential being lost due to slowing or declining vehicle utilization; (2) incremental gasoline demand being captured by electrical vehicles and alternative fuels such as methanol; and (3) greater use of vehicle sharing services that “consolidates” gasoline demand into a subset of more efficient vehicles.
- Factors 2 and 3 are direct products of central and local government policies—such as restrictions on license plate issuance and local policies that promote methanol as a vehicle fuel. Restrictions on car ownership that impose steep financial costs and in some cases make it administratively impractical to own a personal car (for instance due to years' long waits to get a license plate) also help increase the attractiveness of car sharing ride services. Such hindrances may also stimulate greater use of public transport.
- Finally, the increasing penetration of small and micro electric vehicles into lower-tier cities and the rural market may curtail gasoline demand growth that would have otherwise originated from those areas. In some instances, drivers who might have bought a used gasoline vehicle for their first car may instead buy small, cheaper electric vehicles. If these new drivers did not already have deeply held preferences for internal-combustion cars, they will likely stay electric for the remainder of their driving lives, thus permanently foreclosing potential gasoline demand.

Macro Trends

China's Gasoline Demand Still Growing

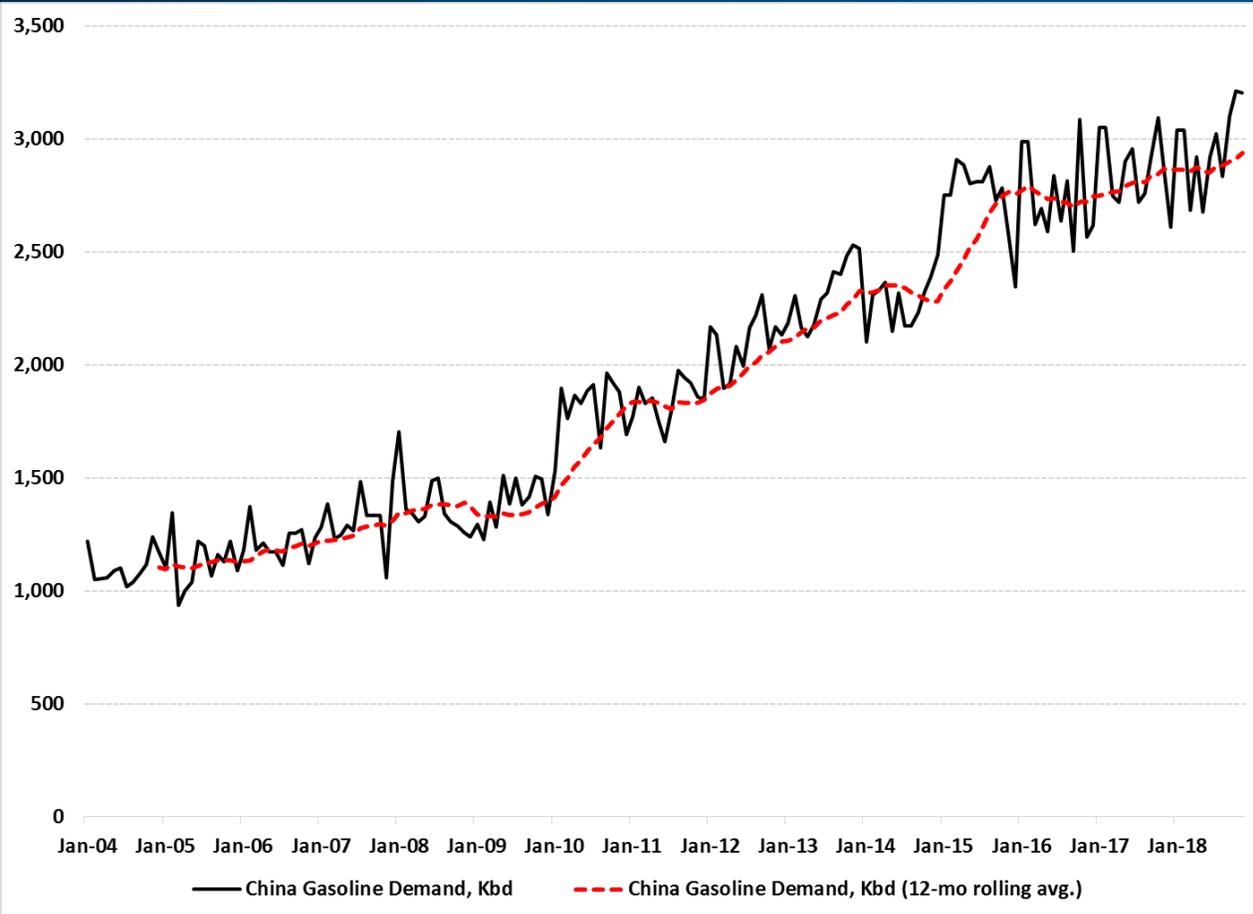
China Apparent Gasoline Demand Over the Past 10 Years, '000 Bpd



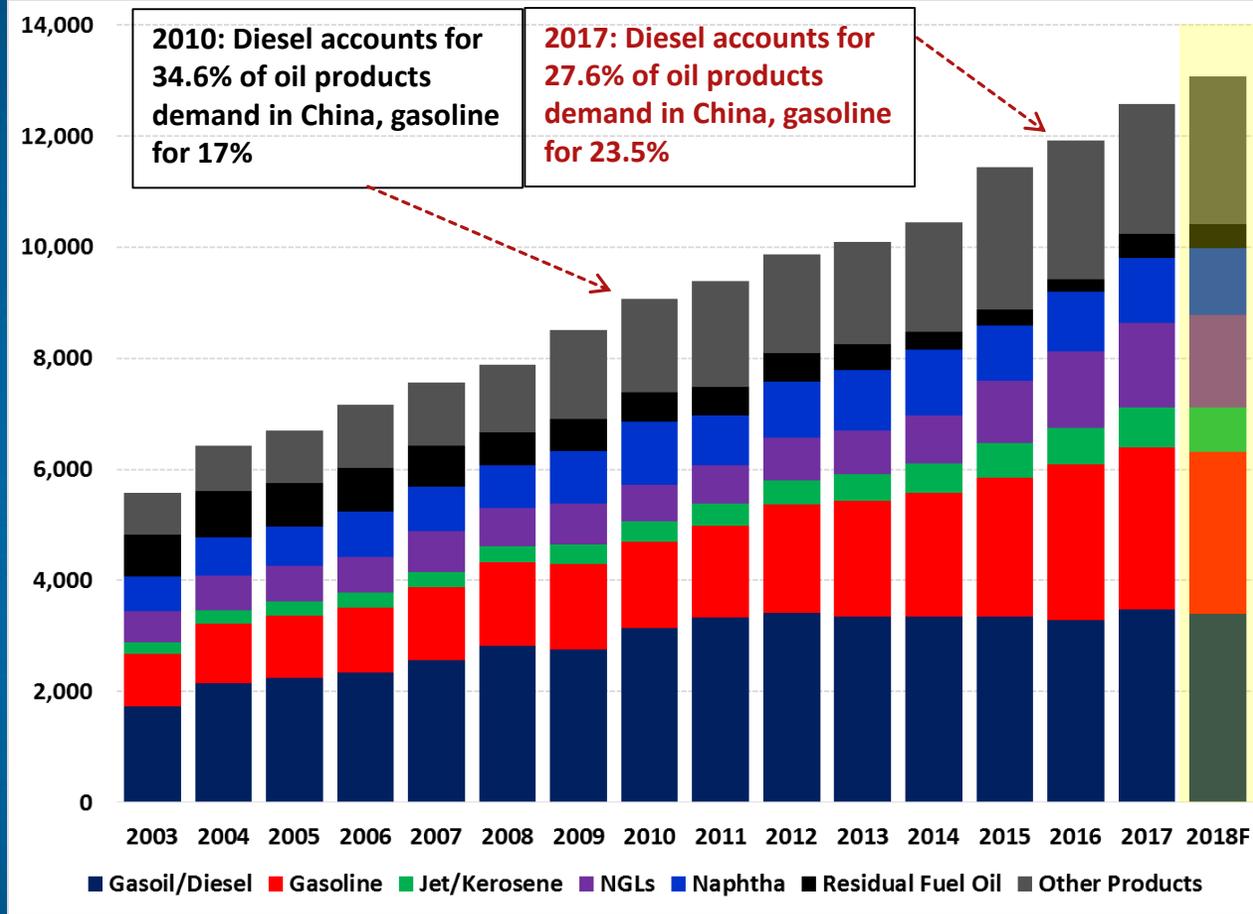
- Gasoline demand broke from the previous 2 years' trend in the second half of 2018.
- 2016 and 2017 month-to-month volume ranges tracked each other closely.
- The break-out in late 2018 came as new car sales slowed, which suggests higher driving activity.
- "Increases" in apparent gasoline demand may also stem from gasoline accounting methodology changes. For the 2018 year, oil products classified as "Other" accounted for nearly 21% of China's total oil consumption and about 70% of incremental growth in 2018.
- Given that some of these "Other" product streams could potentially be blended into gasoline, more comprehensive tracking of such flows that are ending up in the motor fuel pool could also give the impression of increased gasoline consumption.

But...China's Gasoline Demand Growth Rate Has Slowed Over The Past 3 Years

China Gasoline Demand, '000 bpd



China Oil Products Demand, '000 bpd



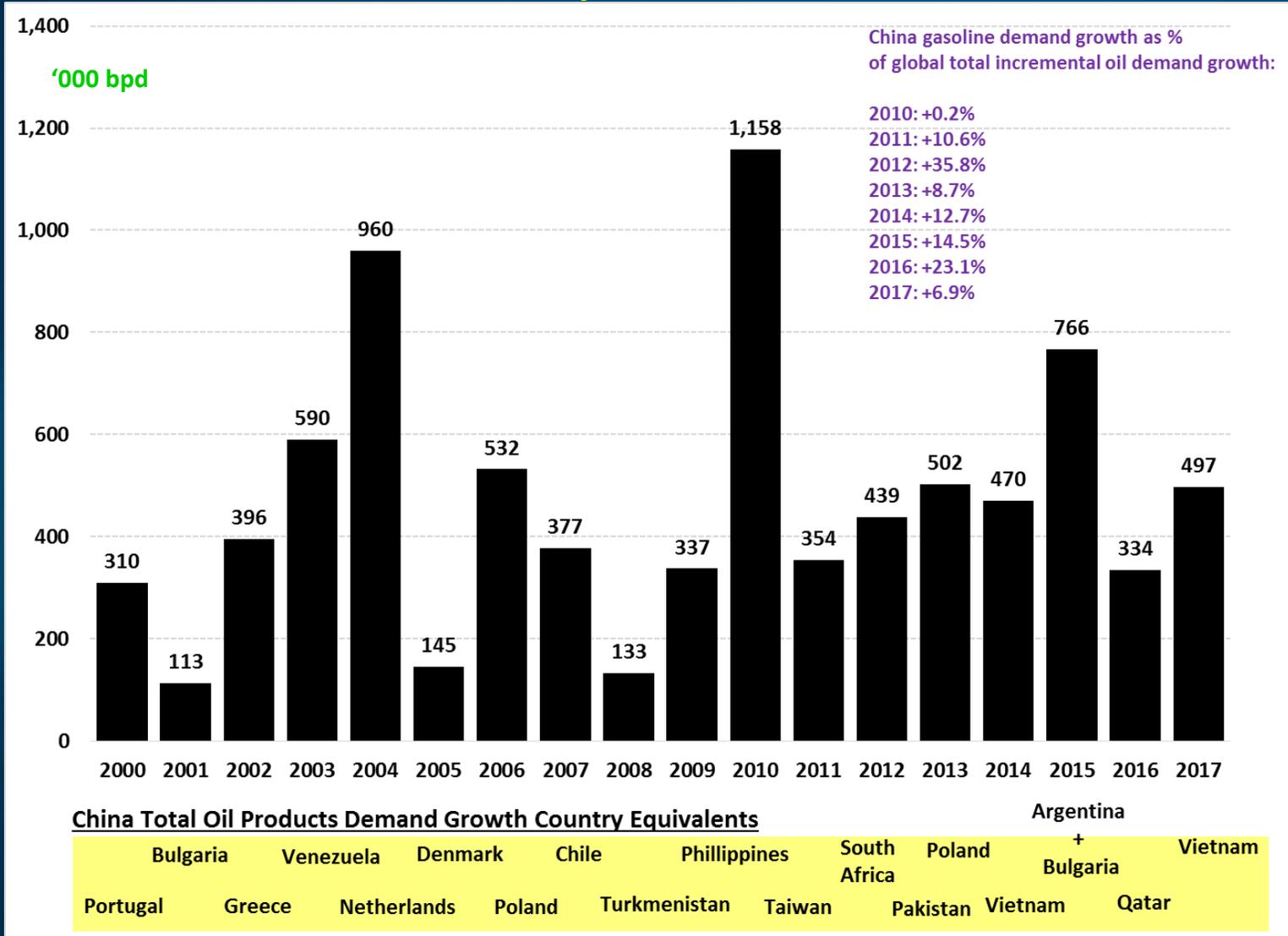
Source: JODI, IEA Oil Market Report, Author's Analysis

Core Question:

Is China's Gasoline Demand in 2018 Approaching the Same Type of Inflection Point That Diesel Demand Was in 2010?

Why Should the World Care About Gasoline Demand in China?

China's Incremental Oil Demand Has Powered the Global Market For Nearly Two Decades and Gasoline Has Played a Vital Role in That Since 2010



China gets traffic jams, air pollution, and a new set of economic opportunities



Source: The Telegraph

While oil producers experience a boom...

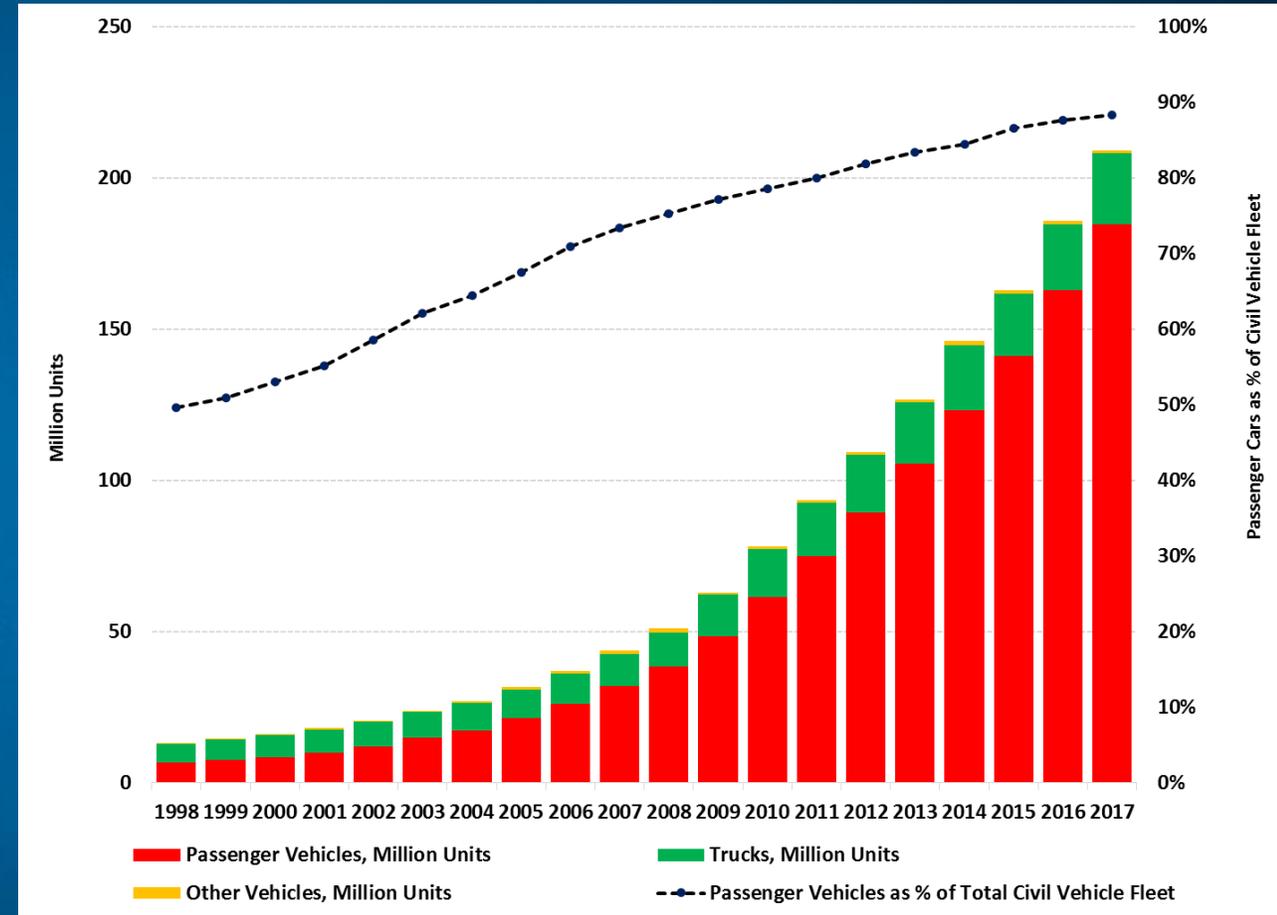


Source: JPT

And Why Does The Analysis Focus on Gasoline?

- First, diesel fuel use at this point is a utilization-centric story, and a stagnating one at that. Gasoline, in contrast is both a utilization and fleet-growth story. Things that shift either of these factors can materially impact refined products demand and trade patterns at the global level.
- Second, if we think about the “crude oil footprint” of the urban consumer class in China, motor vehicle fueling—which is almost exclusively gasoline for internal combustion cars—is the dominant factor driving oil usage per person. An urbanite using 80 kg of plastics per year effectively consumes about 1 barrel of oil equivalent from that activity. But a car owner who drives 15 thousand km per year can consume nearly eight times that amount of oil equivalent, with most of the input actually coming from crude oil.

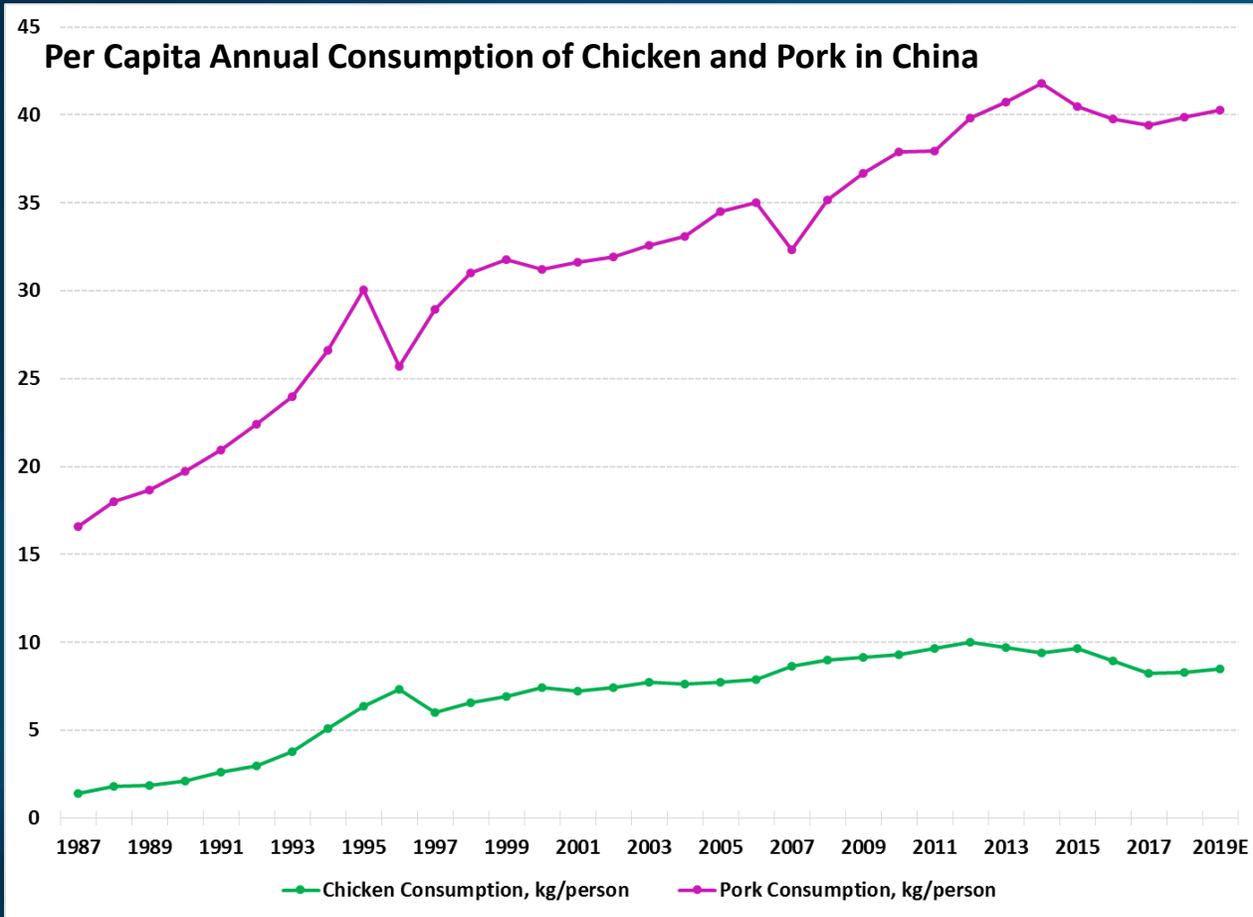
Passenger Vehicles Dominate China's Vehicle Fleet And the vast majority are gasoline-powered



Source: NBS China, Author's Analysis

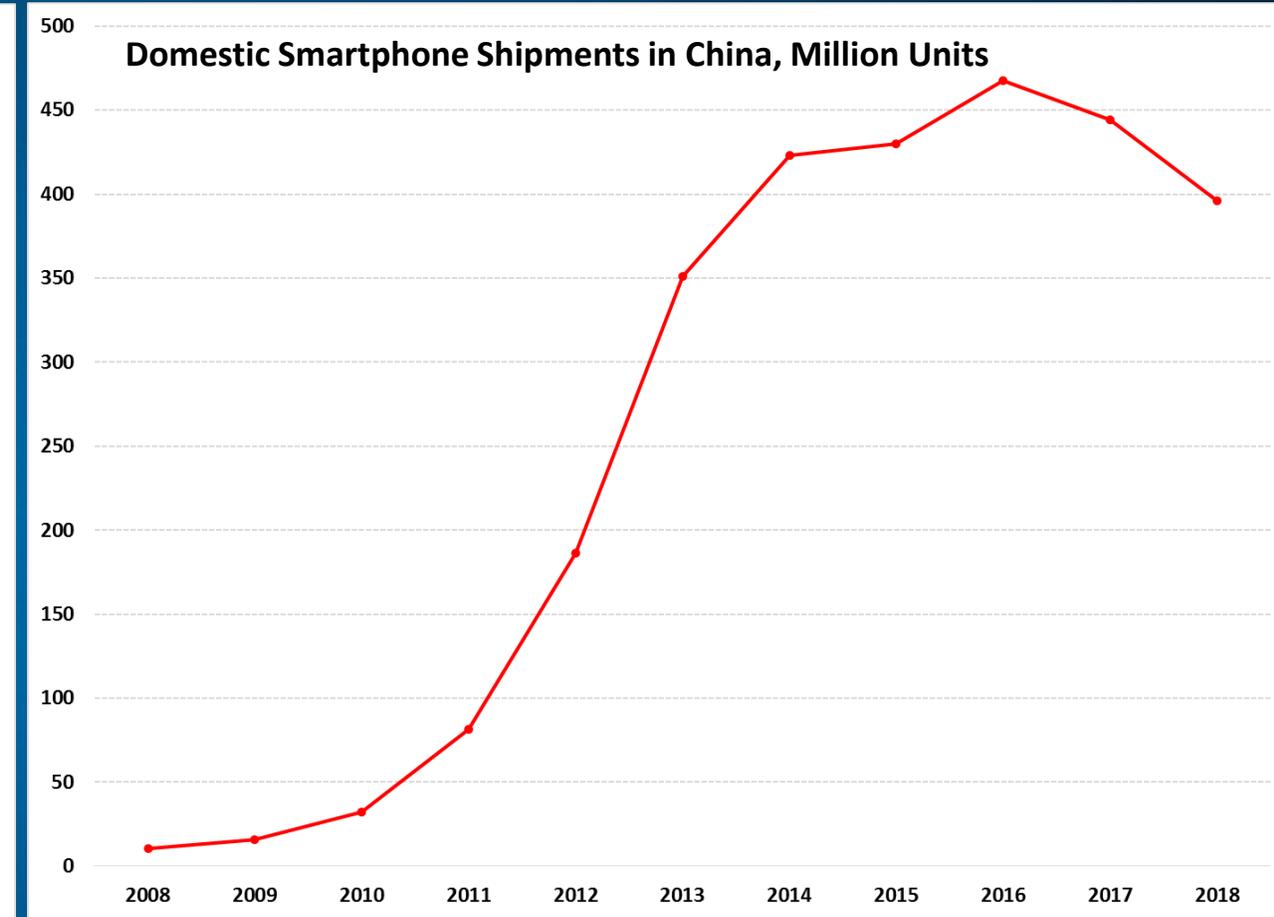
What Can Other Consumer Patterns Teach Us About Gasoline Demand in China?

Long Cycle Consumer Goods: Staple Meats



Source: IMF (population), USDA

Short Cycle Consumer Goods: Smartphones

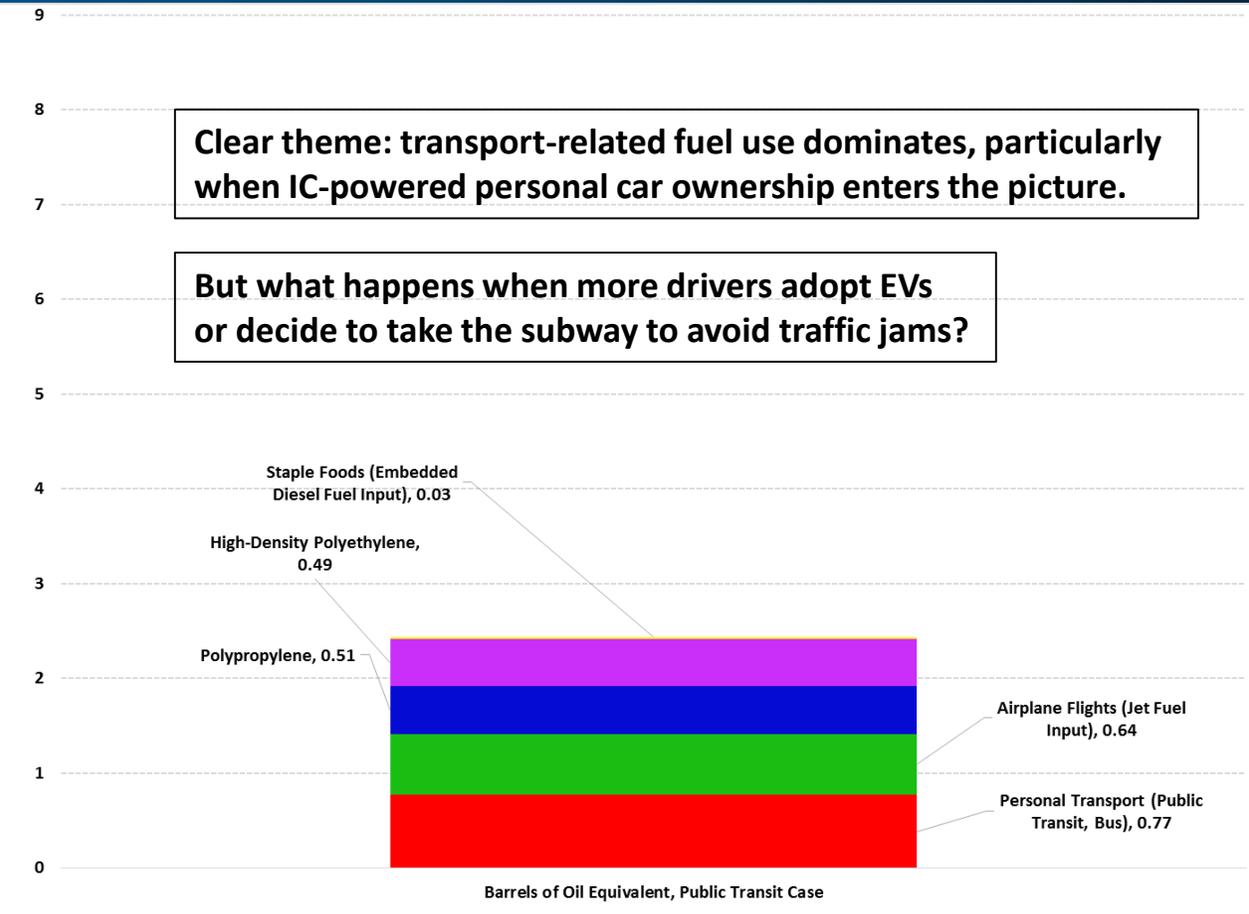
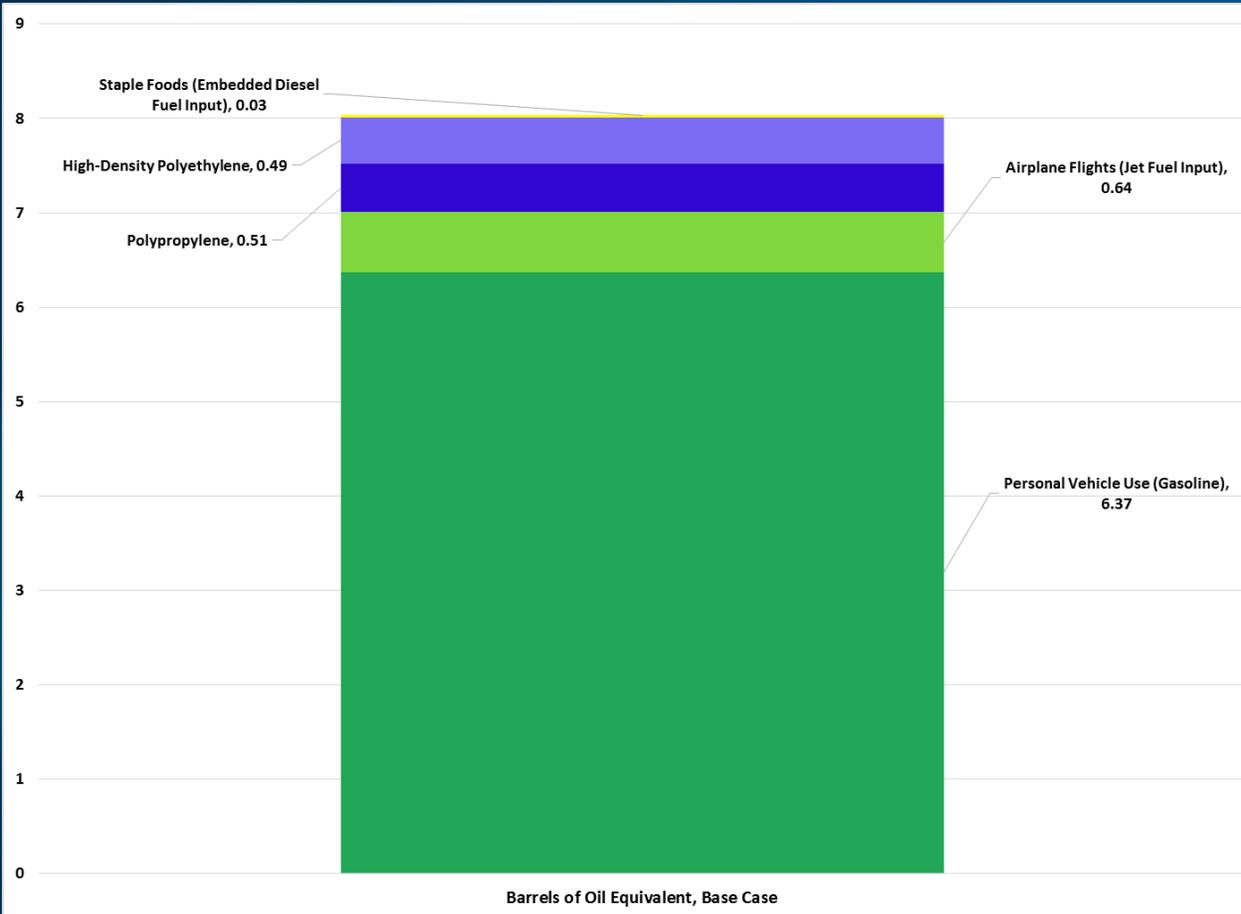


Source: Canals, TechCrunch, TechNode

Gasoline will likely not be completely like either of the goods shown—think of it instead as a “medium cycle” consumer good. Particularly in urban China, there are now arguably more personal transportation service options available to consumers than there are varieties of protein. Gasoline consumption also often incorporates a luxury component that consumption of staple foods does not—i.e. the “Sunday drive” vs. the daily lunch. And unlike technology, a consumer who buys a gasoline consumption object (a/k/a car) has generally spent at least an order of magnitude more money than someone buying a cellphone. So they won’t want to replace it as quickly and the initial purchase/consumption growth/finally reaching saturation cycle will play out much more slowly. Smartphones are turned over about every 3 years on average, while vehicles are often driven 3-4 times longer than that.

“Crude Oil” Footprint of Hypothetical Urban Chinese Consumer

Chinese Urban Consumer, Direct and Indirect Crude Oil Use Estimate, Bbl/yr



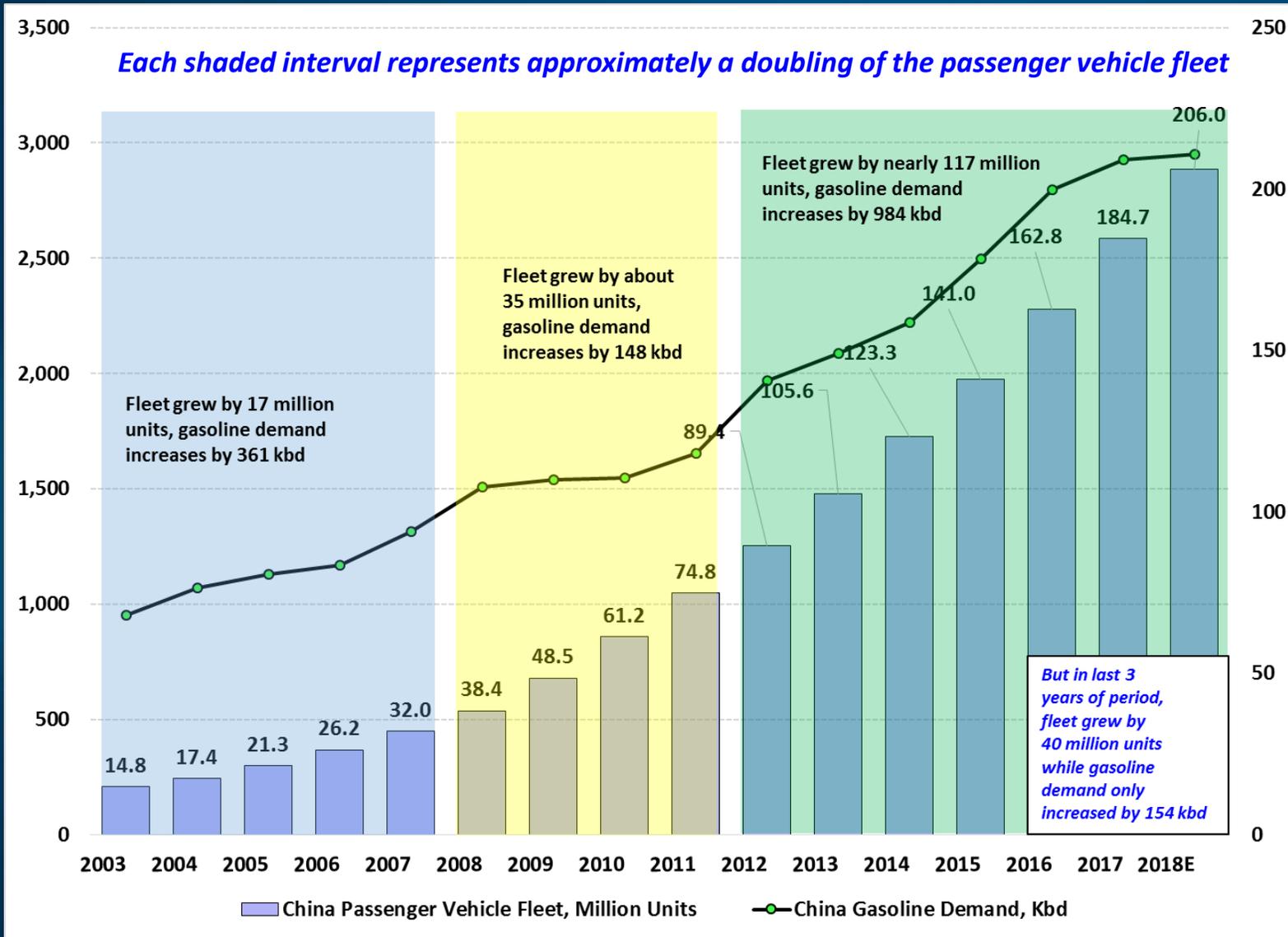
Source: Academic Publications (available upon request), ICIS, NBS China, USA Today, Author's Estimates

Chinese Consumer “Crude Oil Footprint” Methodology Notes

- ▶ Food-related crude oil footprints estimated on the basis of how much diesel fuel is needed to plant, till, and harvest the crops, plus how much fuel is likely needed to transport the crops to market. Staple grains covered are corn, rice, soybeans, and wheat.
- ▶ For vegetables, we use a crop budget showing estimated fuel use of a commercial tomato farming operation in California’s San Joaquin Valley near Fresno.
- ▶ For meat, we apply an estimated feed conversion ratio to calculate how many kilograms of grain (and by extension, how much diesel fuel) are embedded in the meat Chinese consumers are eating.
- ▶ For dairy products, we assume that cows are fed a mix of alfalfa, corn, and soy as detailed in data from the University of Arkansas. We use a crop budget from Texas A&M to calculate how much diesel fuel is likely required to produce a given tonnage of alfalfa.
- ▶ For plastics, we use various data sources indicating the total embedded energy content for high-density polyethylene and polypropylene and multiply this by data from ICIS estimating the total annual plastics demand of consumers in Beijing for the year 2016. To make the plastics data, which are a “derivative” oil use, directly comparable to the other “consumptive” oil uses, we calculated each oil use’s heat content in BTU and converted that into “barrels of oil equivalent” at the commonly used rate of 6 million BTU per barrel of crude oil.
- ▶ Potential errors: The crop oil footprint analyses omit pesticide use under the assumption that the oil inputs are less than the diesel fuel needs. Fertilizers are omitted because most nitrogen fertilizers are produced using either natural gas feedstock, or in some parts of China, coal. This could comprise a significant source of error and make our food production oil usage numbers overly conservative. In addition, the olefin feedstocks for plastics can be manufactured from crude oil, natural gas, or coal. This analysis assumes that naphtha from crude oil is the primary feedstock for HDPE and PP made and consumed in China, as has traditionally been the case in East Asia more generally. However, polymers are traded in a fungible global market and an increasing proportion of global supplies are derived from natural gas and natural gas liquids from the US. China also has a meaningful amount of internal olefin production derived from coal feedstock. As such, a meaningful proportion of plastics consumed in China at any given point in time may in fact not be produced using crude oil.

China's Car Fleet Now Growing Significantly Faster Than Gasoline Demand Is

China's Gasoline Demand vs. Passenger Vehicle Fleet Growth



2012-2018 fleet growth and fuel demand growth

Car Fleet Growth	Gasoline demand growth
130%	50%

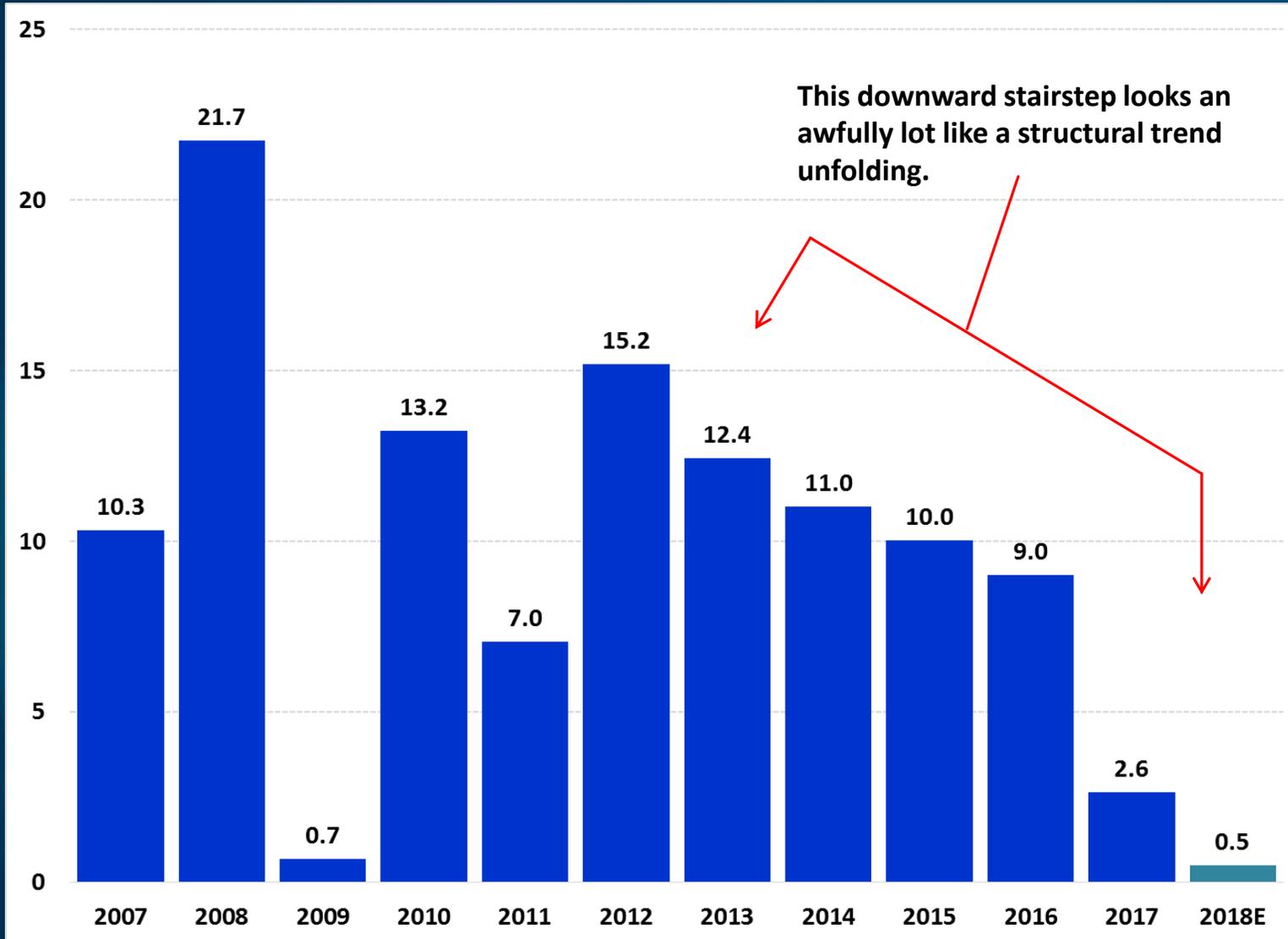
Growth rate slows in past 3 years...

2016-2018 fleet growth and fuel demand growth

Car Fleet Growth	Gasoline demand growth
27%	6%

China New Car Sales' Declining Gasoline Demand Growth Leverage: Is a Decoupling Underway?

'000 Bpd of Gasoline Demand Increase vs. Million New Passenger Cars Sold



- ▶ No single factor fully explains the trend, but the confluence of several dynamics begins to paint a picture of slower than anticipated gasoline demand growth in China during the next 5 years.
- ▶ First, roads are becoming crowded, which leads drivers to think twice before they plunge into traffic jams and also stimulates municipal crackdowns on car registrations and usage.
- ▶ Second, the growth rate of new passenger car sales has been slowing—and sales actually slightly declined in 2018.
- ▶ Third, used vehicle sales account for an increasing portion of total car sales. Each month, nearly a million current and aspiring Chinese drivers now purchase a used car.
- ▶ Fourth, generous subsidies, preferential license plate issuance policies, and convenience factors are supporting strong EV sales growth—particularly the low-cost and easy to park “mini EVs” becoming popular in many cities.

Why China's Declining Gasoline Demand Growth Leverage to New Car Sales Catches Our Attention

- China's private passenger car fleet is very much in growth mode (roughly 9 out of 10 new cars sold in China drive net fleet growth. Normally, one would expect gasoline demand to grow apace.

	Private Passenger Vehicles, Million Units	Private Passenger Car Fleet Increase, Million Units	New Car Sales, Million Units	Net Fleet Increase Per New Car Sold, Units	Vehicle Fleet, YoY change	Gasoline Consumption, Kbd	Gasoline Consumption, YoY Change
2007	23.2	4.9	6.2	0.80	27.1%	1,314	12.4%
2008	28.8	5.6	6.7	0.84	24.3%	1,507	14.7%
2009	38.1	9.3	10.3	0.90	32.2%	1,539	2.1%
2010	49.9	11.8	13.8	0.86	31.0%	1,546	0.5%
2011	62.4	12.5	14.5	0.86	25.0%	1,655	7.1%
2012	76.4	14.0	14.4	0.98	22.5%	1,967	18.9%
2013	92.0	15.6	17.9	0.87	20.4%	2,088	6.2%
2014	109.5	17.5	19.7	0.89	19.0%	2,223	6.5%
2015	127.4	17.9	21.2	0.84	16.4%	2,499	12.4%
2016	149.0	21.6	23.9	0.90	17.0%	2,797	11.9%
2017	170.0	21.1	24.2	0.87	14.1%	2,927	4.6%
2018E	190.7	20.7	23.7	0.87	12.2%	2,939	0.4%

Source: NBS China, IEA Oil Market Report (gasoline demand)

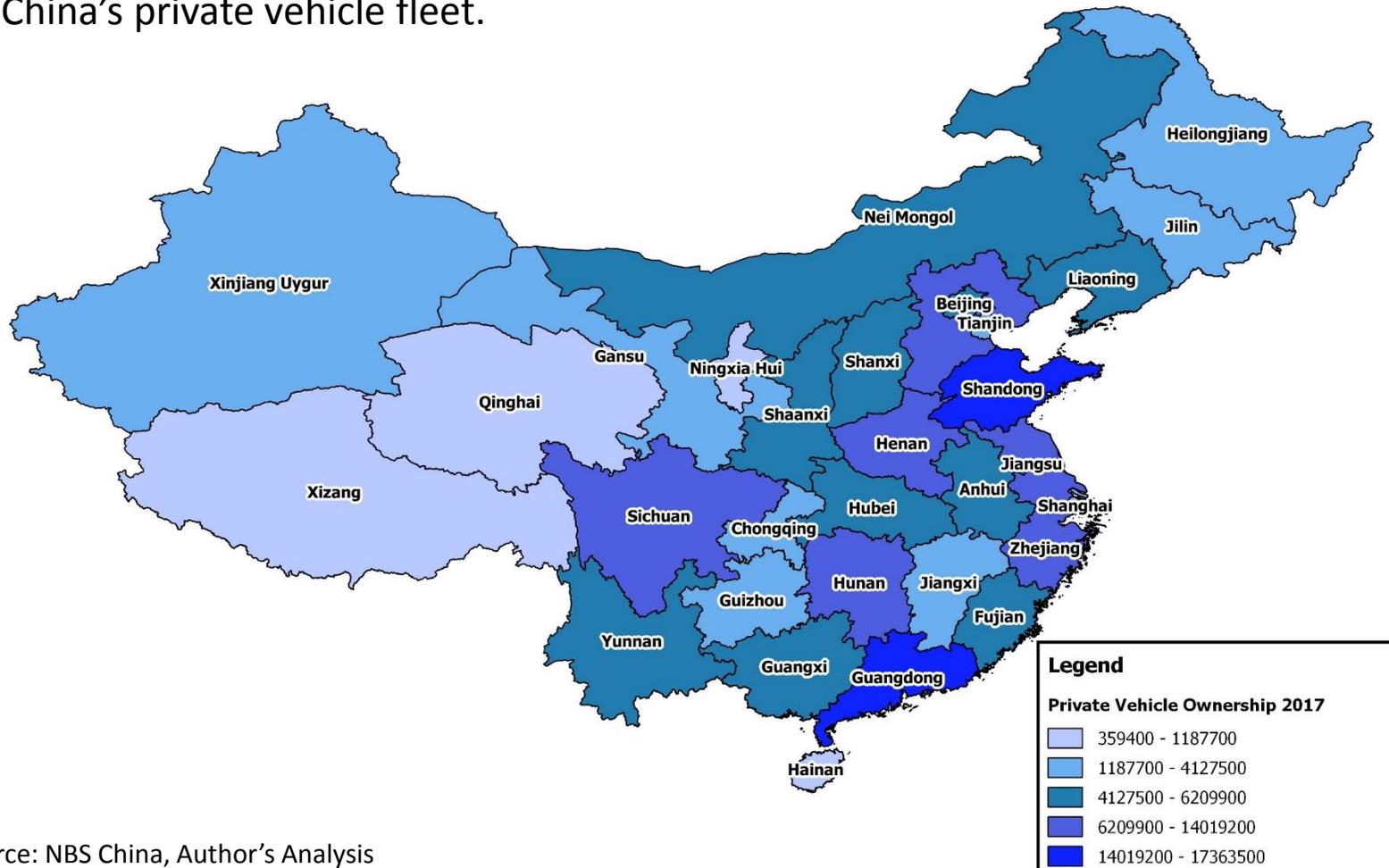
Breaking Down China Gasoline Demand Drivers: Some Key Dynamics That We'll Analyze More Deeply

- One core dimension is “how many cars are on the road today in China and how are ownership trends evolving?”
- A second key dimension is “how much do Chinese car owners drive their steel and alloy steeds?”
- A third dimension is “what factors could discourage people from driving and how have these evolved in recent years?”
- A fourth dimension is “what energy sources are propelling passenger cars in China and how, if at all, is this picture evolving?”
- A final dimension is: “what are the strategic implications if China’s gasoline demand growth structurally plateaus in the way that the country’s diesel fuel use has in recent years?”

Dimension 1: Car Ownership Trends

Where in China Do People Own The Most Cars?

The 10-largest vehicle owning provinces account for 61% of China's private vehicle fleet.

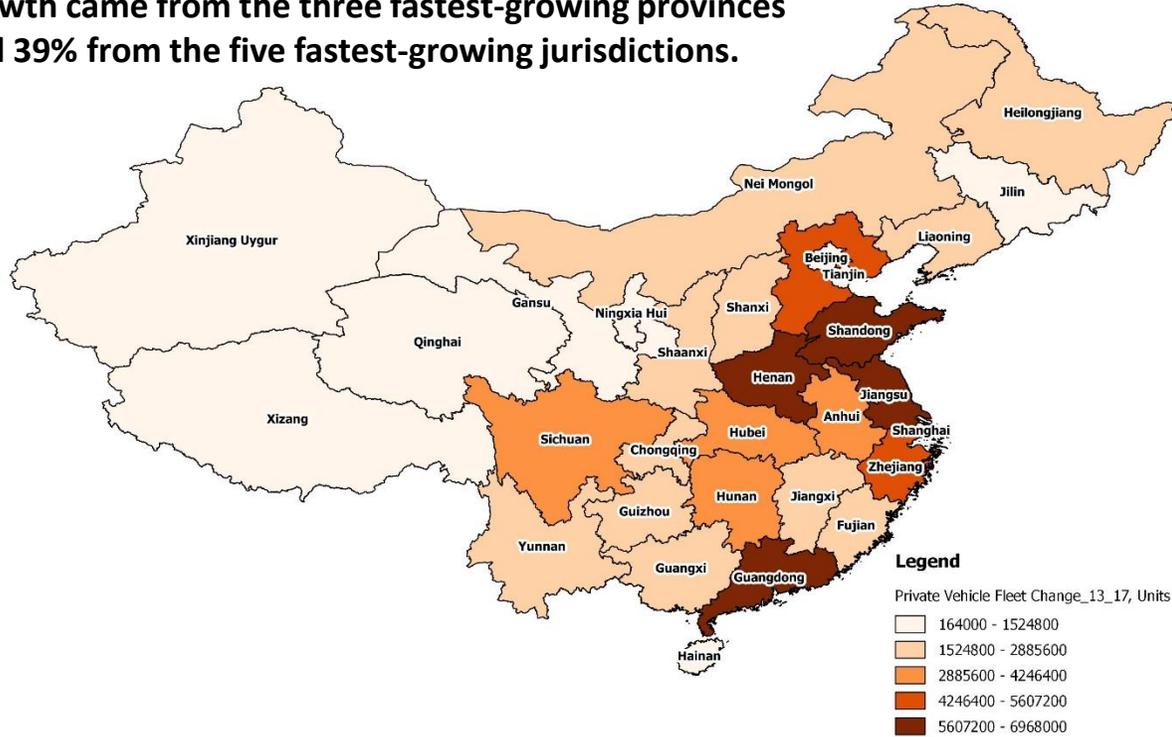


- Key car-owning coastal provinces typically feature the lowest miles-driven figure.
- That is of course with the proviso that multiple vehicle ownership is also more common in these wealthier areas, which could skew individual vehicles' annual km driven down, while still maintaining high aggregate levels of vehicle use and gasoline demand.
- In essence, a household with one vehicle that drives 20,000 km/yr likely uses less gasoline than a household that has two vehicles each driving 12,000 km/yr.

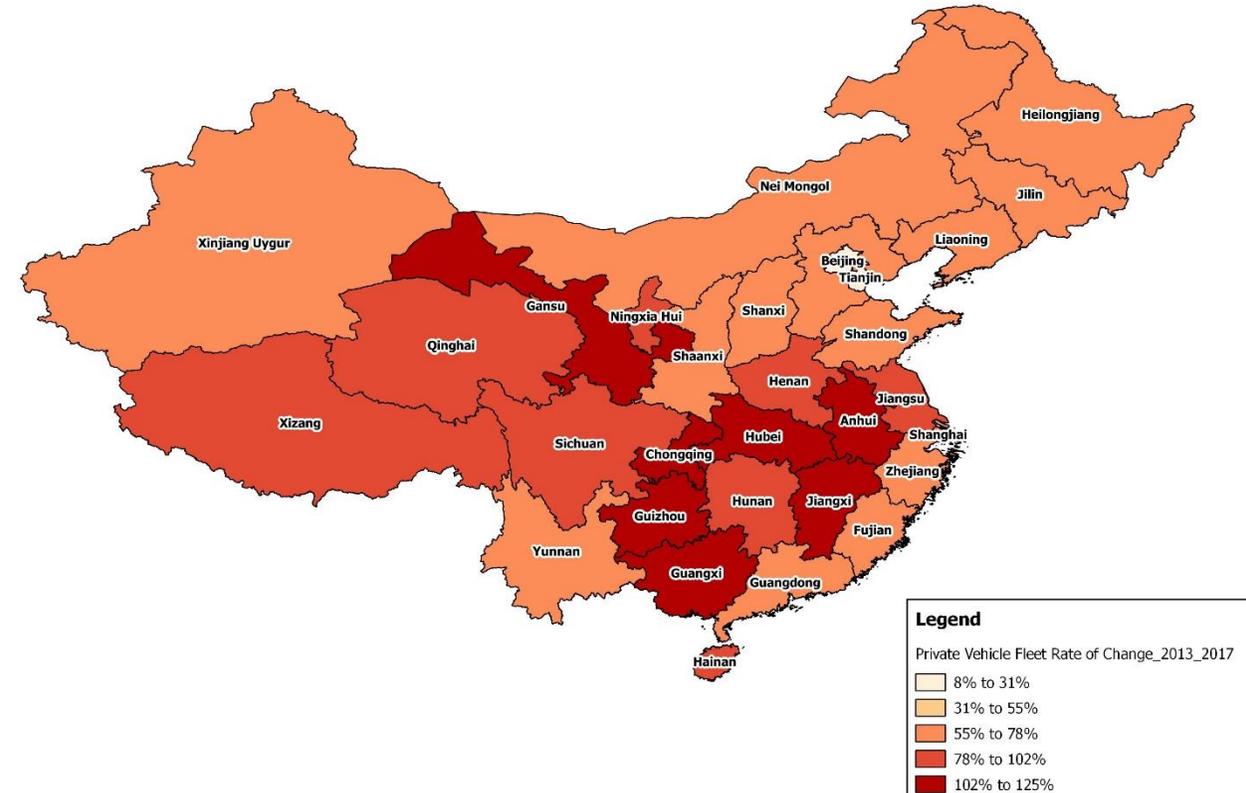
Car Ownership Trends in China Over Past Five Years: Volume vs. Rate

China Private Vehicle Fleet Change 2013-2017, Units

China's private vehicle fleet grew by 80 million units between 2013 and 2017. Twenty-five percent of this growth came from the three fastest-growing provinces and 39% from the five fastest-growing jurisdictions.



China Private Vehicle Fleet Rate of Change 2013-2017, % YoY

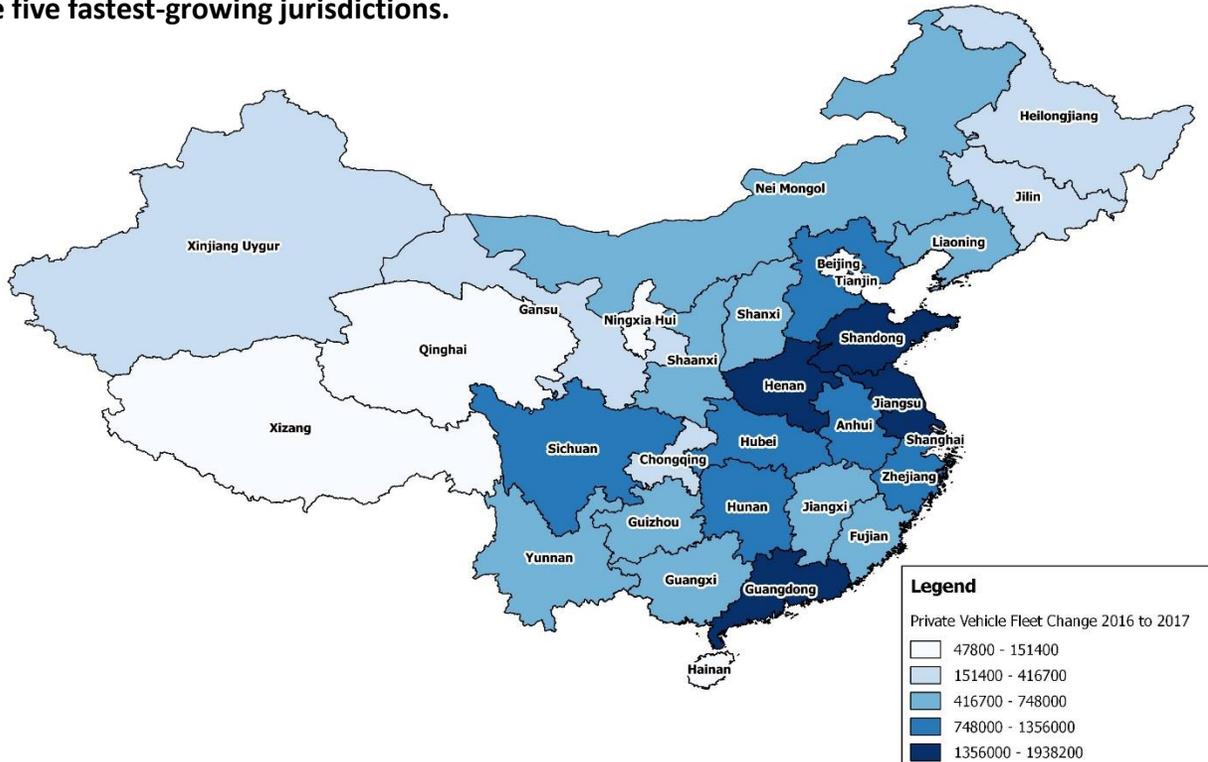


Source: NBS China, Author's Analysis

Car Ownership Trends in China Between 2016 and 2017: Volume vs. Rate

China Private Vehicle Fleet Change 2016-2017, Units

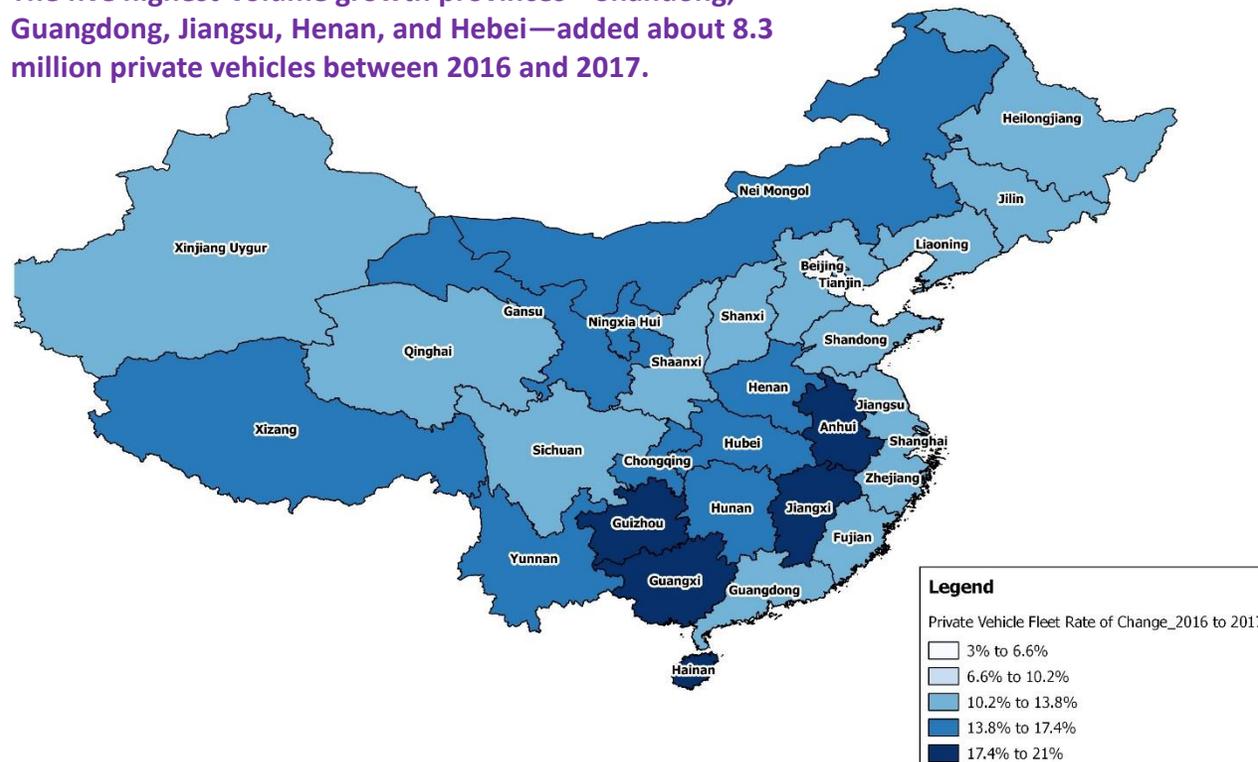
China's private vehicle fleet grew by almost 22 million units between 2016 and 2017. Twenty-five percent of this growth came from the three fastest-growing provinces and 38% from the five fastest-growing jurisdictions.



China Private Vehicle Fleet Rate of Change 2016-2017, % YoY

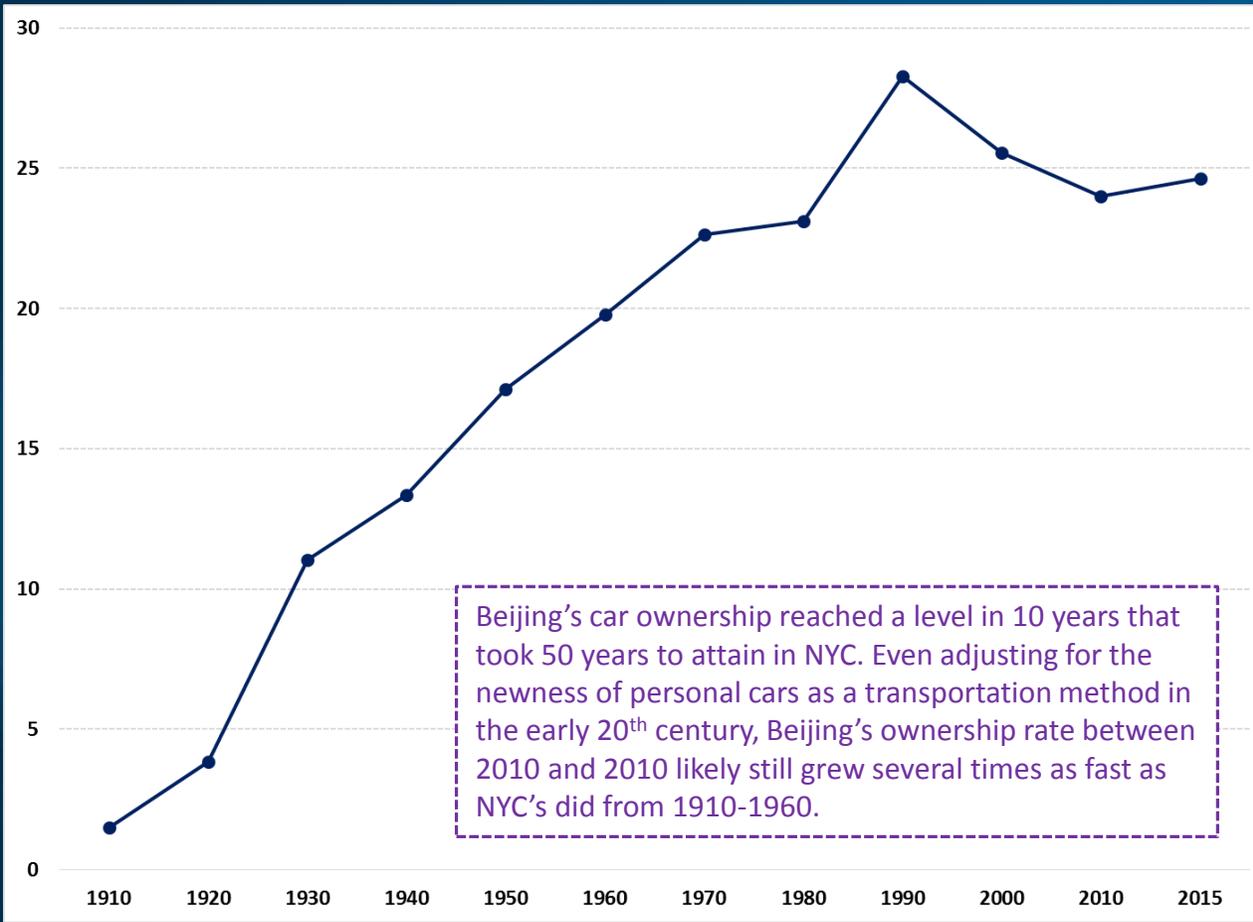
The five fastest-growing provinces—Anhui, Guangxi, Guizhou, Hainan, and Jiangxi—added about 3.2 million private vehicles between 2016 and 2017.

The five highest-volume growth provinces—Shandong, Guangdong, Jiangsu, Henan, and Hebei—added about 8.3 million private vehicles between 2016 and 2017.



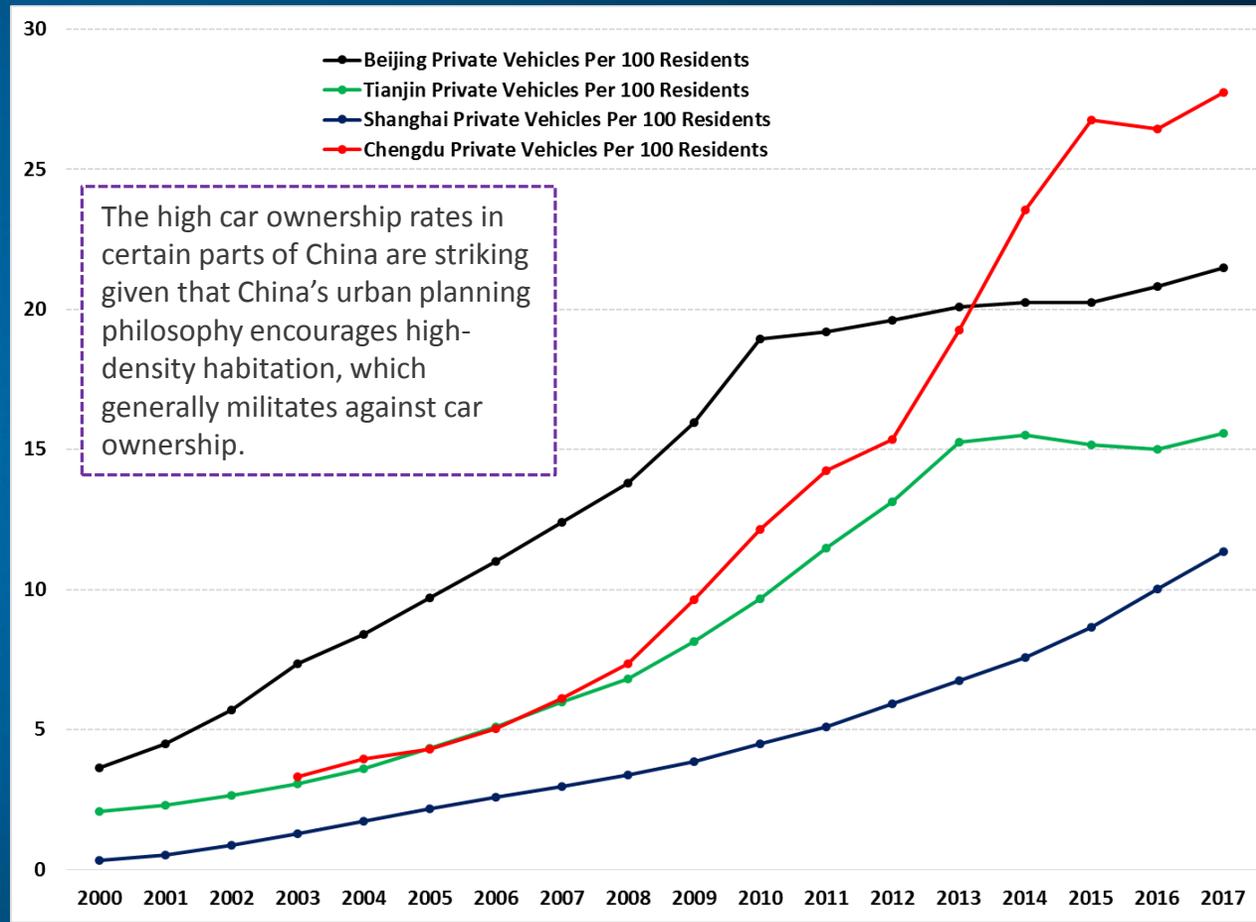
Key Chinese Cities Now Have Private Car Ownership Rates Approaching—And Sometimes Exceeding—New York City's

New York City Registered Cars Per 100 Residents



Source: New York City Mobility Report (October 2016)

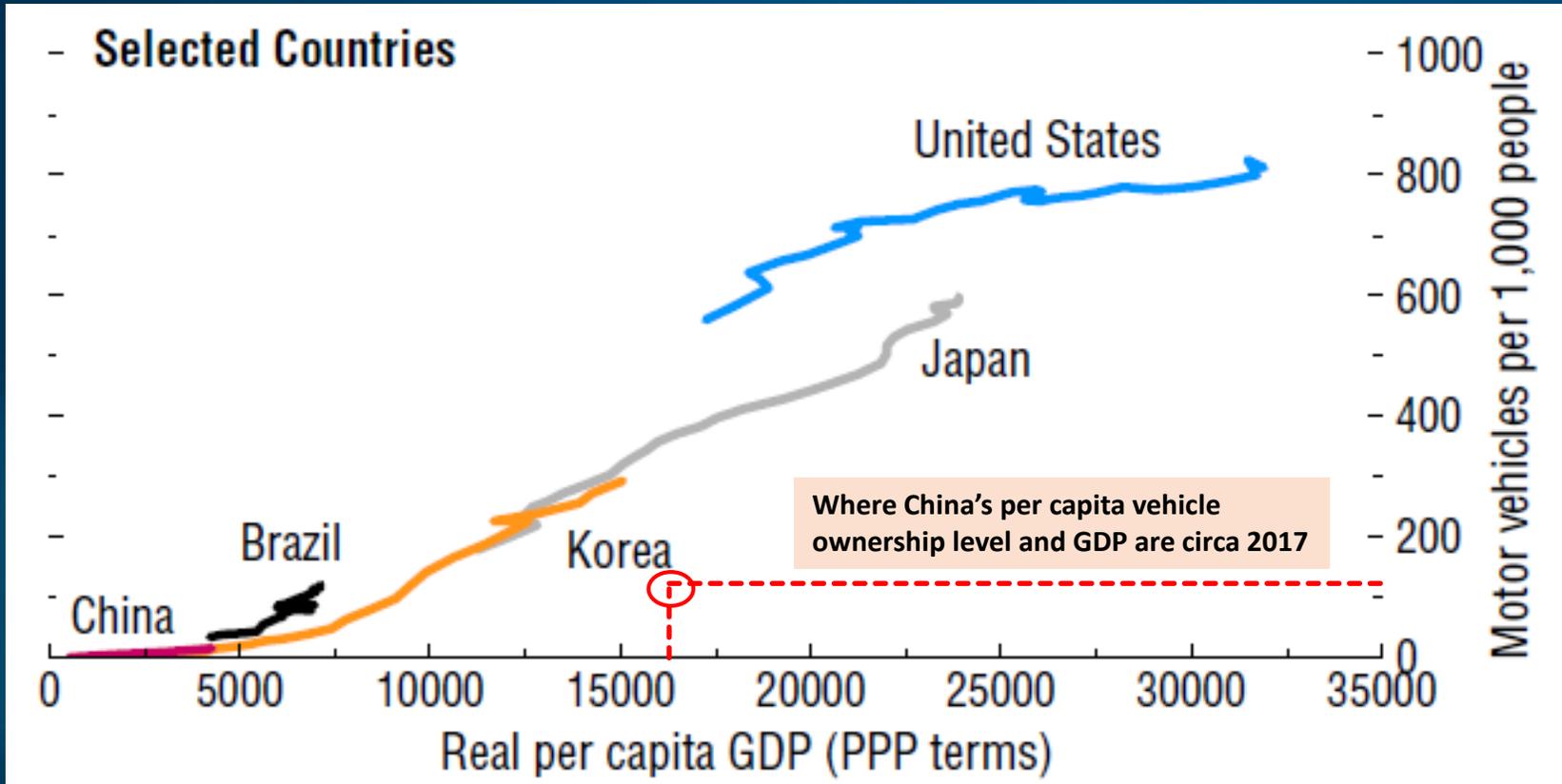
Private Cars Per 100 Residents in Selected Chinese Cities



Source: NBS China, Local Statistical Bureaus

Car Ownership Plateaus: Physical vs. Economic vs. Political Factors

Vehicle Ownership vs. Per Capita Income (1971-2002)



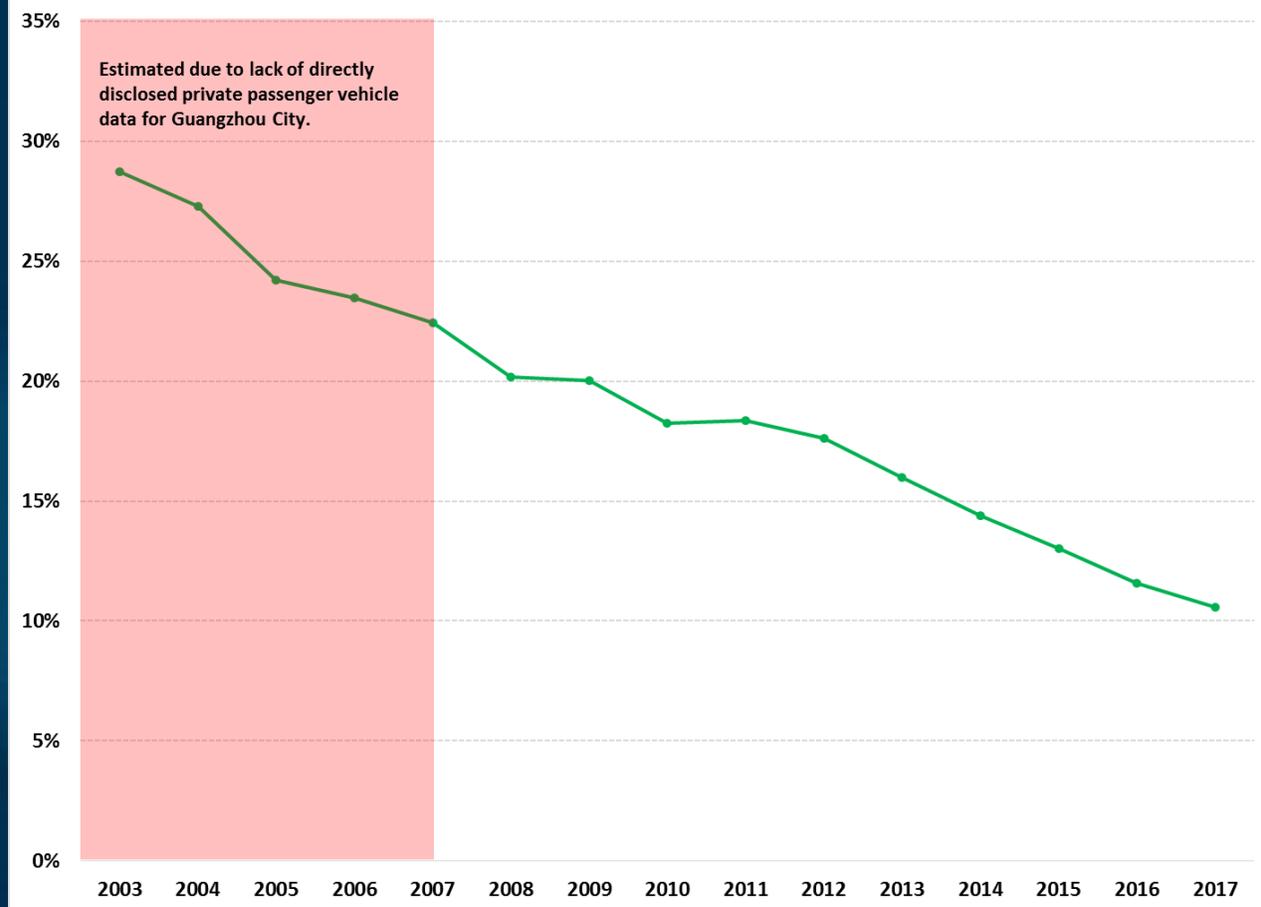
Source: CIA World Factbook, UN Statistical Yearbook, OECD, IMF Staff Calculations

- ▶ The United States is an outlier in many ways due to its unique combination of high income, favorable geography (i.e. large sprawling urban areas), vehicle-centric culture, and largely successful popular opposition to policies designed to constrain motor vehicle ownership.
- ▶ Governments in Japan, Germany, and other high-income, high auto ownership locations generally work to restrain and discourage vehicle ownership and use through measures including high motor fuel taxes.
- ▶ Key Chinese municipalities are beginning to take a much more coercive approach to (1) restrain car fleet growth and (2) incentivize decreased usage of existing vehicles.

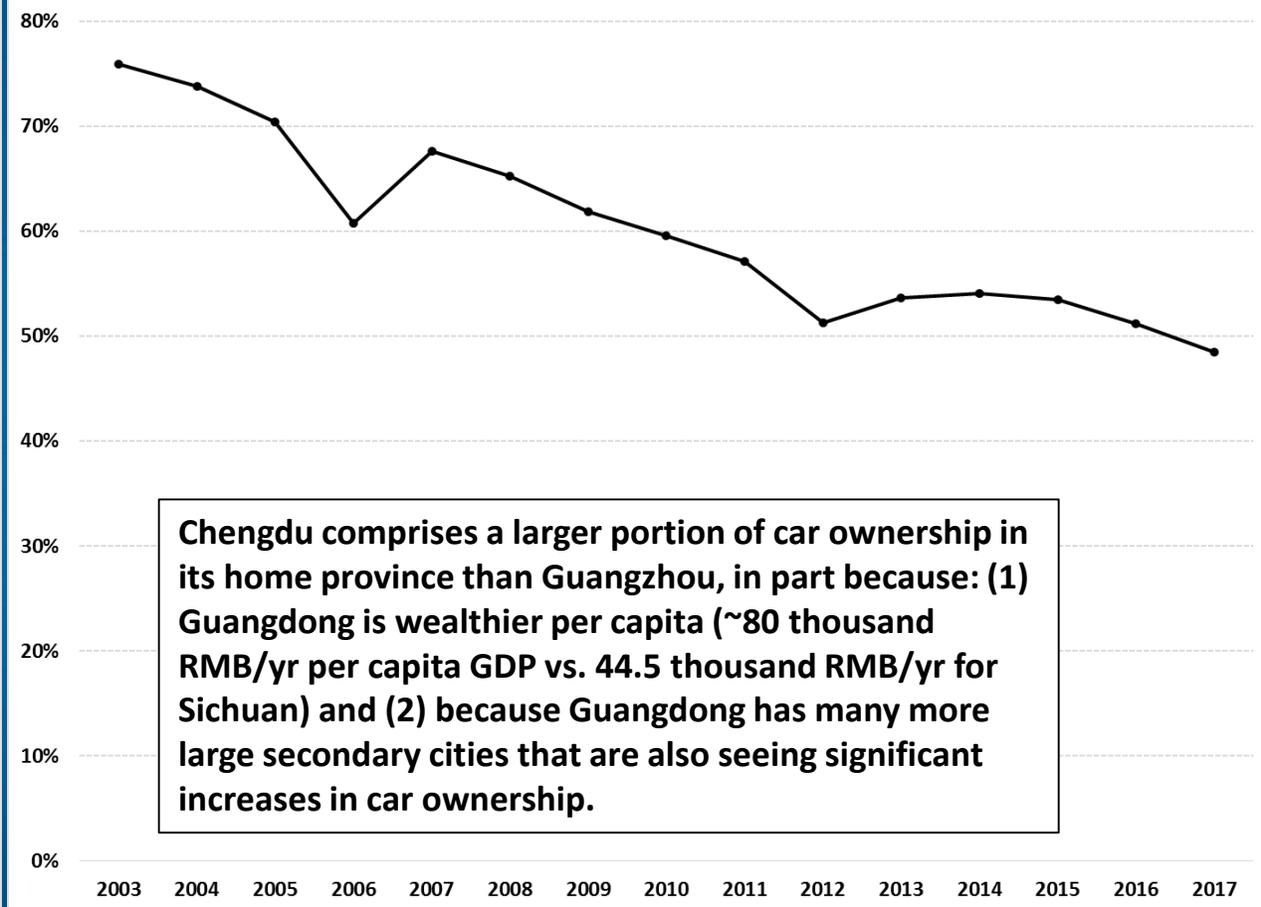
Using other countries' historical patterns as a baseline for comparison suggests China's functional saturation point where car ownership begins to plateau may in fact be significantly lower than the 600 vehicles/1,000 persons rate seen in Japan and the 800 vehicles/1,000 persons level in the United States.

Car Ownership is Diffusing Outside the Dominant City in Key Provinces

Guangzhou Private Car Fleet as % of Guangdong Provincial Total



Chengdu Private Car Fleet as % of Sichuan Provincial Total



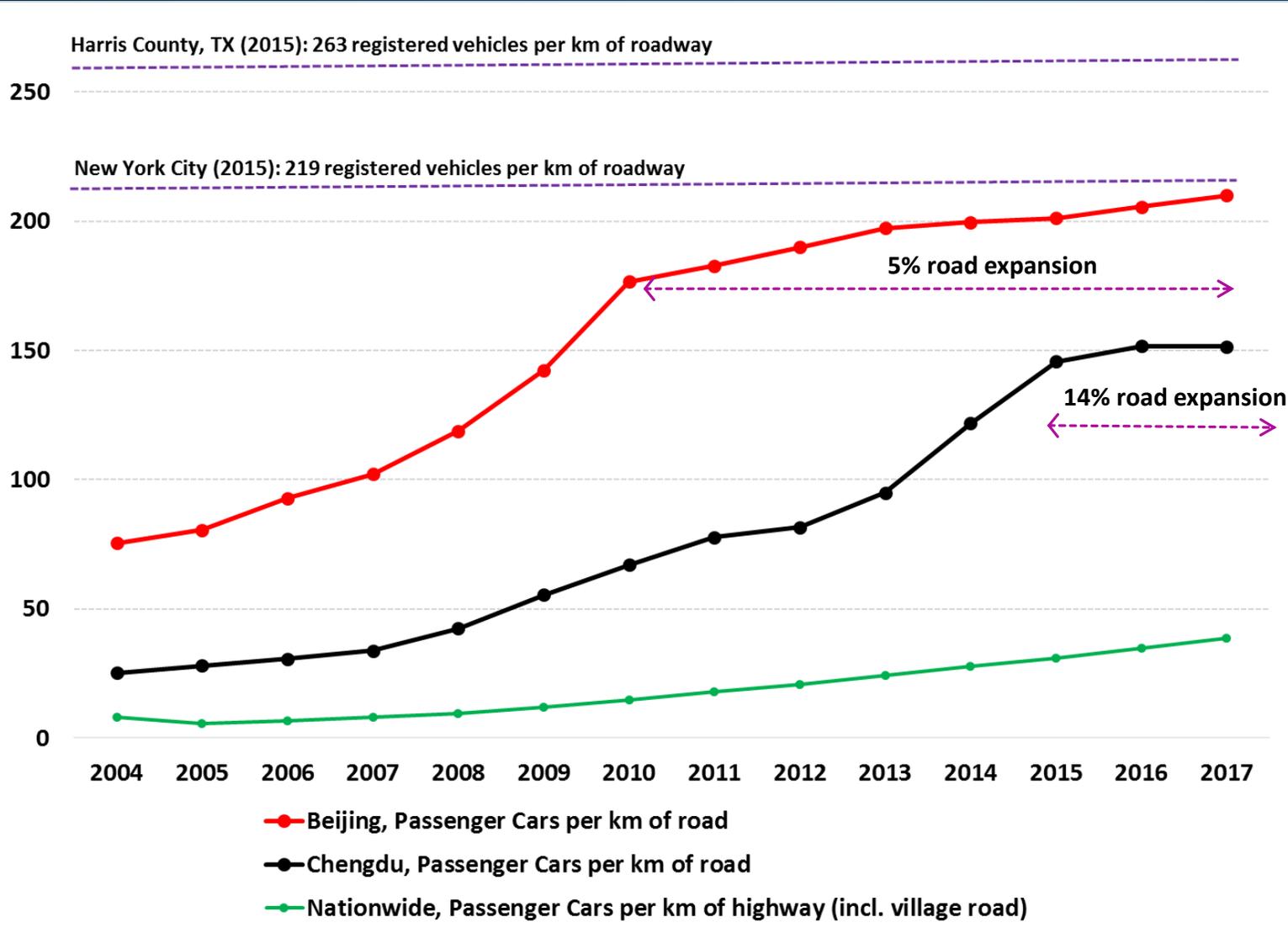
Chengdu comprises a larger portion of car ownership in its home province than Guangzhou, in part because: (1) Guangdong is wealthier per capita (~80 thousand RMB/yr per capita GDP vs. 44.5 thousand RMB/yr for Sichuan) and (2) because Guangdong has many more large secondary cities that are also seeing significant increases in car ownership.

Source: NBS China, Guangzhou Statistics Bureau, Author's Analysis

Sichuan and Guangdong are presently home to a combined total of approximately 200 million people and 26 million cars

Are Key Chinese Car (and Gasoline) Markets Heading Toward “Peak Car?”

Motor Vehicles per Kilometer of Roadway

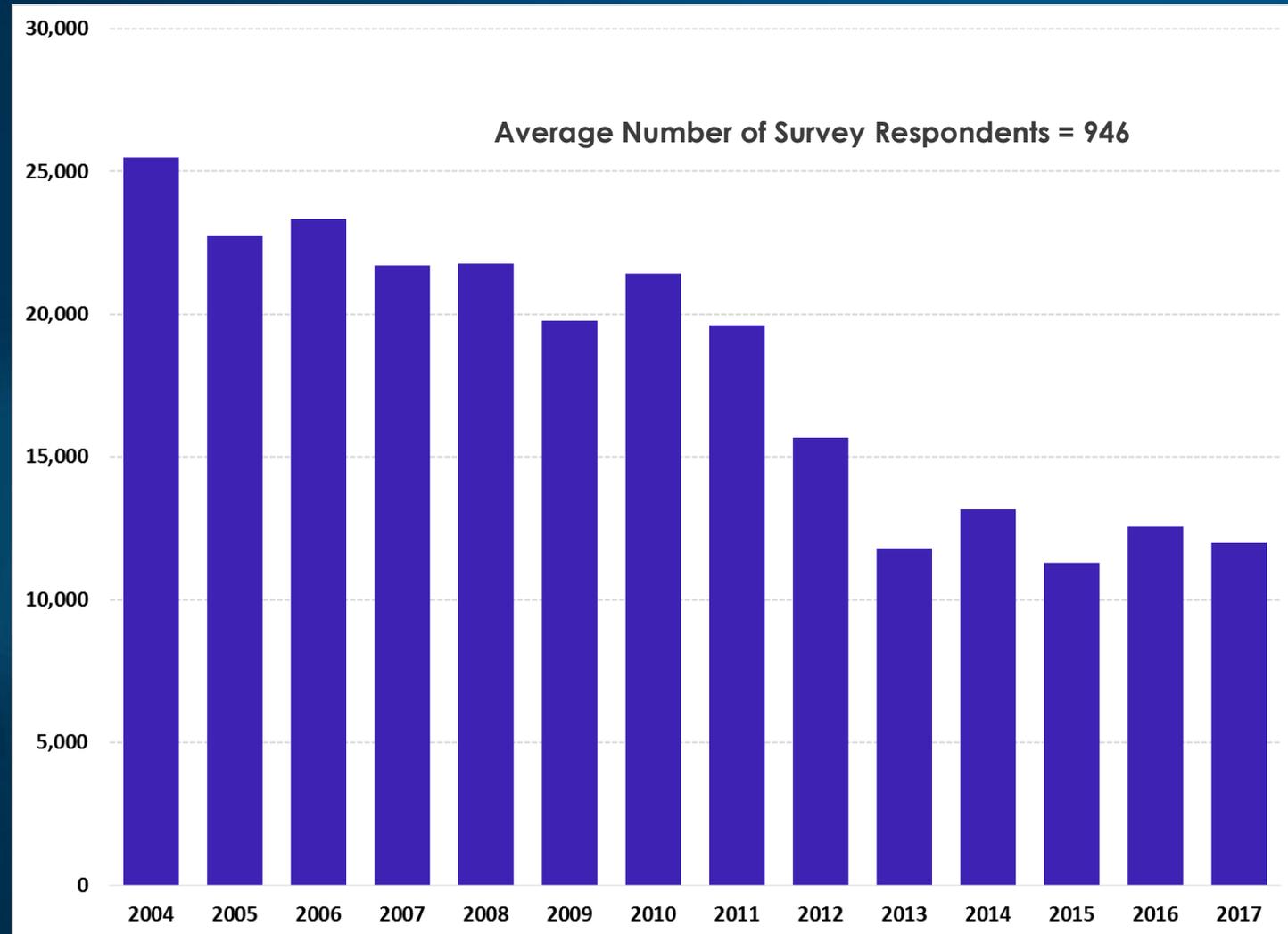


- One possible proxy for road congestion, albeit a highly imperfect one, is to see how many cars exist in a given geographical zone per kilometer of roadway.
- The BYD F3, a common compact sedan sold in China, is about 5 meters long. Thus, in a single traffic lane, approximately 200 of these vehicles could fit bumper-to-bumper. Chinese arterial roads generally have multiple lanes. Yet even with several traffic lanes available in each flow direction, average vehicle densities exceeding 150 vehicles per km of roadway begin to paint a congested picture—particularly during rush hour times when main roads can attract a disproportionate volume of vehicles.
- Multiple key Chinese car markets are nearing US-style vehicle densities and per capita car ownership rates, despite the fact that the per capita income in Beijing or Shanghai is still significantly lower than that of Houston, Los Angeles, or New York.
- This raises the question of whether core Chinese gasoline markets could effectively reach Peak Car through “congestive road failure” where vehicle volumes, geographical constraints, and perhaps also fiscal obstacles render them unable to build their way out of persistent traffic congestion that deters vehicle use. Consider Chengdu, for instance, where the city has expanded the length of its road network by 14% in the past three years, but is basically only able to hold traffic densities steady in a market where the private passenger car fleet expanded by 8% (nearly 300 thousand vehicles) in 2017 alone.

Dimension 2: Driving Behavior in China

How Is Car Usage—a/k/a “Miles Driven”—Trending in China?

Snapshot 1: Kilometers Driven per Year in Beijing, China’s Signature Car City



Source: Beijing Transportation Research Center

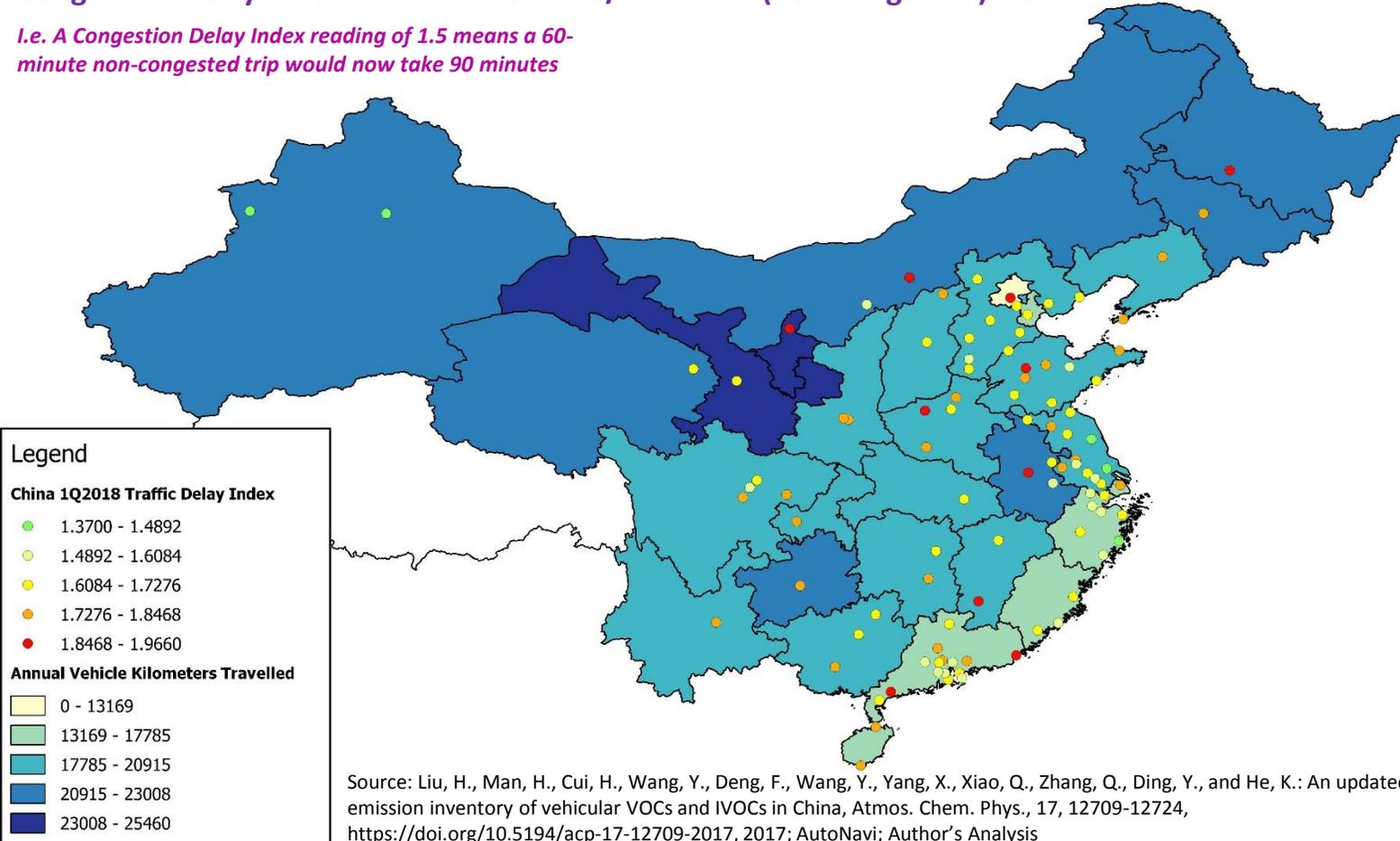
- Data from surveys run by the Beijing Transportation Research Center suggest the annual vehicle kilometers travelled (“VKT”) basically halved between 2004 and 2017.
- During the 14 years shown, several things happened. First, the city’s vehicle fleet grew enormously and traffic congestion worsened commensurately, which likely dampened enthusiasm for driving. Second, the city began imposing restrictions on car usage around the time of the 2008 Olympics and has subsequently tightened them (Ma and He). Third, driving restrictions helped prompt car-owning families to acquire additional vehicles, which helps drive down the average annual usage of a specific car.

Driving Levels in China (2015 Vintage): What Latent Gasoline Demand Potential Do the Lower-Tier Cities and Countryside Offer?

China Annual Light-Duty Vehicle KM Travelled in 2015 vs. 100 Most Congested Cities in China (1Q2018)

Congestion Delay Index = Peak Travel Time/Free Flow (non-congested) Travel Time

I.e. A Congestion Delay Index reading of 1.5 means a 60-minute non-congested trip would now take 90 minutes



- Of the 25 most traffic-congested Chinese cities in 1Q2018, only three are so-called “Tier-1” cities (Beijing, Guangzhou, and Shanghai).
- Many other municipalities in AutoNavi’s 1Q2018 dataset lie hundreds of kilometers from the coastal prosperity belts that have helped supercharge car sales in China over the past 15 years.
- China’s interior hinterlands have been viewed as a potential driver of gasoline demand as the Tier-1 (predominantly coastal) cities saturate with cars and implement policies aimed at restraining car ownership and usage.
- The author’s own analysis within the past 5 years took this general position. See, for instance **Gabriel B. Collins and Andrew S. Erickson**, “[Volkswagen’s China Dealership Expansions Suggest Substantial Upside for Continued Growth in Car Sales—and Gasoline Consumption](#),” *China SignPost™ (洞察中国)* 87 (17 December 2014).
- Yet now, two of the large third and fourth-tier Sichuan cities we cited—Deyang and Mianyang—now find themselves on the list of the 100 most congested cities in China. At year-end 2017, Deyang’s passenger car ownership rate of 29 vehicles per 100 residents actually exceeded Chengdu’s 2017 car ownership level of approximately 27 vehicles per 100 residents.
- Repeated broadly across China, such trends may suggest that the lower tier cities do not hold the previously believed level of latent gasoline demand potential.

**Dimension 3: Factors That Do—or
Could—Influence Car Ownership and
Usage in China**

Factors Potentially Deterring Greater Car Ownership in China

		Would stop owning a car	Would refrain from buying a car
		Car Owners	Prospective Buyers
Traffic Congestion	Significantly Worse	32%	29%
	Moderately Worse	16%	13%
	Does Not Get Worse	11%	5%
Average Gasoline Price	9.5 RMB/l (\$5.46/gal)	31%	27%
	8.5 RMB/l (\$4.88/gal)	13%	9%
	7.5 RMB/l (\$4.31/gal)	11%	5%
Taxi Availability	Easy	18%	7%
	Moderate	11%	5%
	Difficult	11%	5%
Car Rental Accessibility	Easy	13%	6%
	Moderate	12%	5%
	Difficult	11%	5%
Development of Public Transport	Targeted Improvement	11%	6%
	Intermodal Connectedness	10%	5%
	Comprehensive Improvement	8%	5%
Cost of Obtaining a Local Car Plate	Difficult	N/A	8%
	Moderate	N/A	6%
	Remains the Same	N/A	5%

- ▶ Traffic congestion was the single most powerful motivator for actual or prospective drivers to consider getting rid of their vehicles or not buying cars in the first place.
- ▶ Congestion's importance as a potential deterrent to car ownership is magnified by the fact that it exists in reality at present, whereas the gasoline price levels that would motivate drivers to re-think car ownership are very high.
- ▶ Under China's gasoline pricing system, reaching the "pain threshold" of gasoline at 9.5 RMB/liter would require Brent crude oil prices approaching \$160/barrel, a level unlikely to be reached in the next 5 years or sustained for more than a brief period.
- ▶ This data is from 2015, when gasoline demand growth in China began to taper. Have drivers' fundamental emotions and dislikes changed materially in the intervening 3 years? Perhaps, but unlikely.

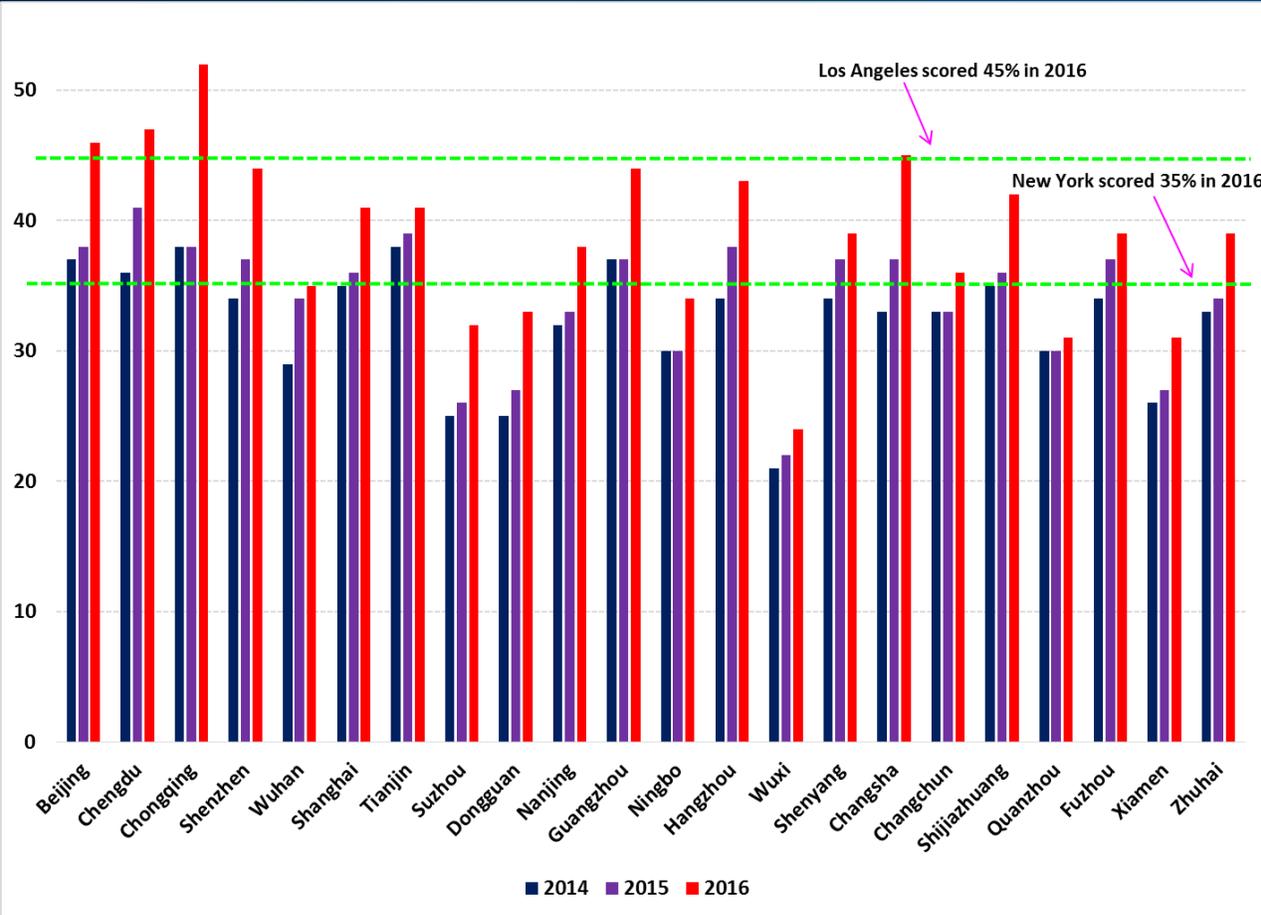
Source: Bain China Mobility Study (2015), Collins, Gabriel. "China's Evolving Oil Demand: Slowing Overall Growth, Gasoline Replacing Diesel as Demand Driver, Refined Product Exports Rising Substantially." (2016)

<http://www.bakerinstitute.org/research/chinas-evolving-oil-demand/>

Traffic Problems Have Worsened And Car Sales Have Slowed

Traffic Congestion in Key Chinese Gasoline Markets

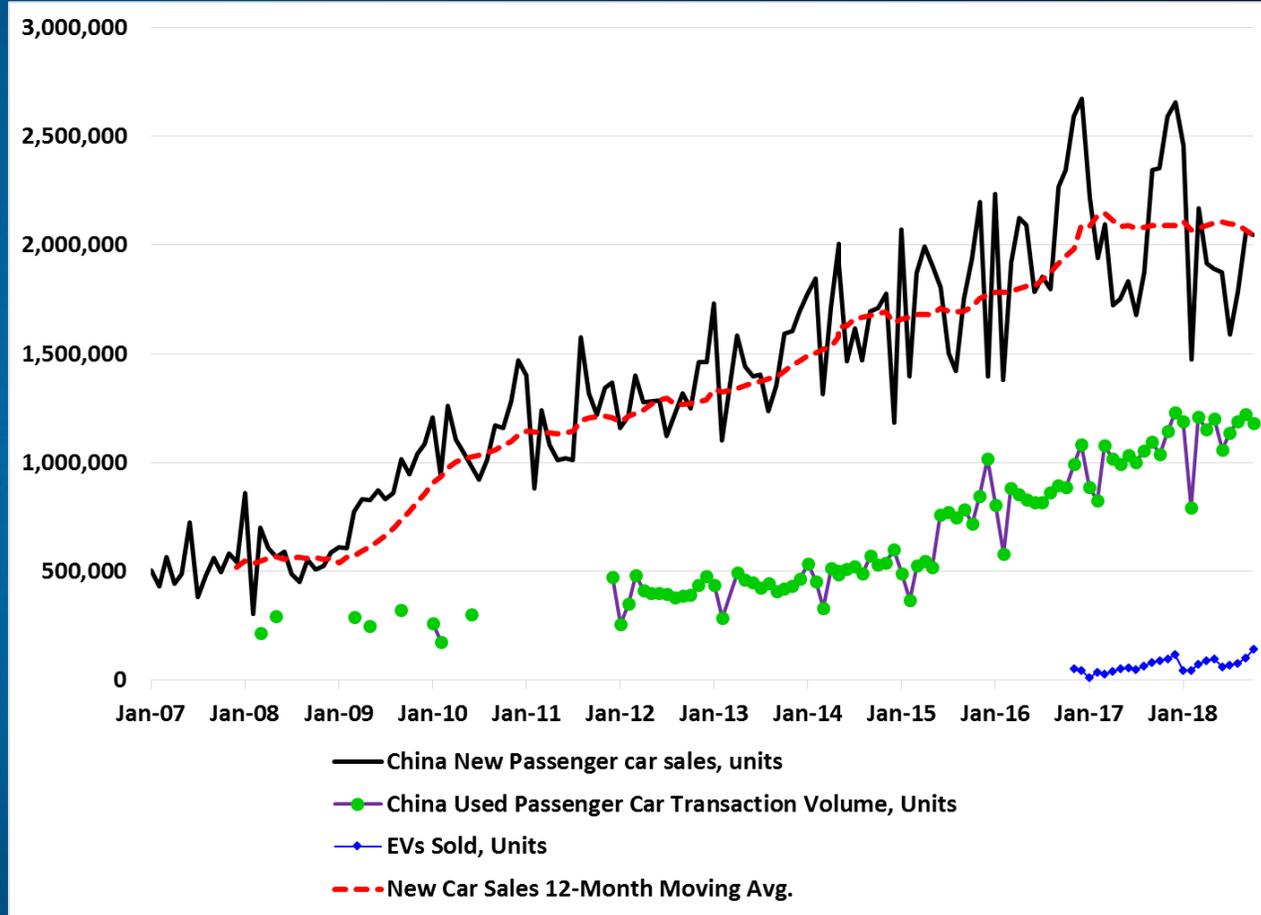
% Increase in Travel Time Relative to Baseline



Source: TomTom, Author's Analysis

China Monthly Sales of New Cars, Used Cars, Electric Vehicles

Units

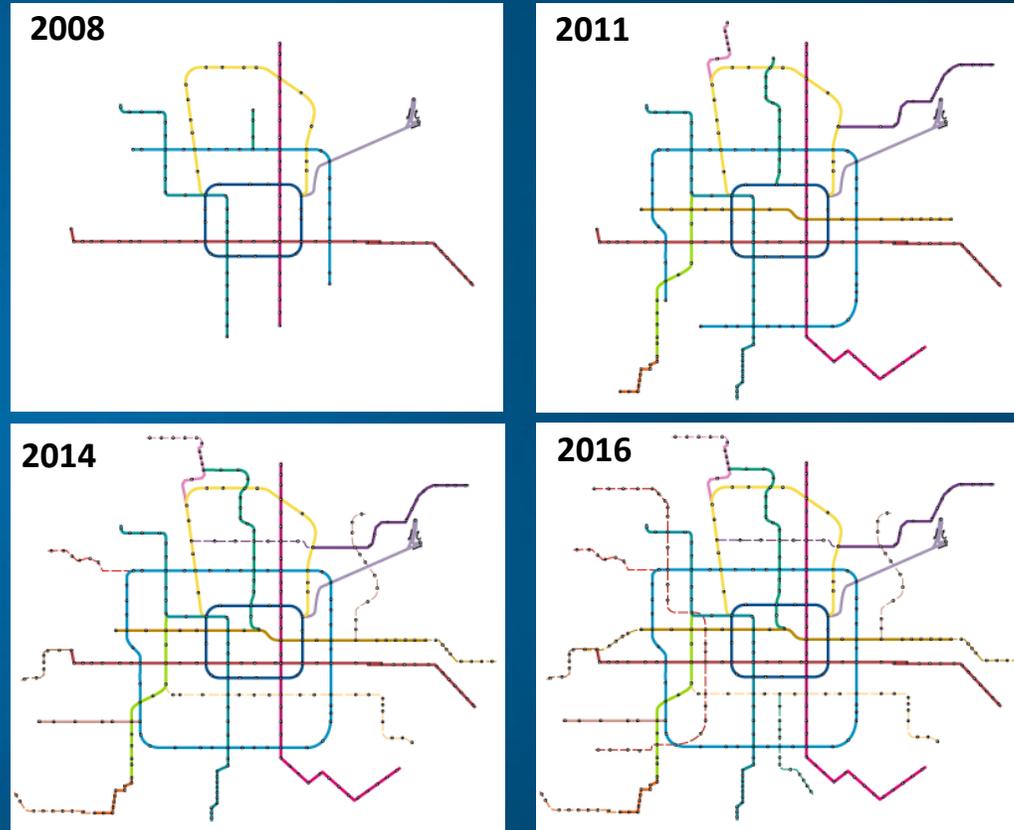


Source: CAAM, CPCA

Other Factors That Could Weigh on Car Ownership in China

- A government crackdown on peer-to-peer lending that crimps potential car buyers' ability to secure financing.
 - P2P platforms accounted for nearly 250 billion RMB of auto loans in 2017, more than 20% of total auto lending in China. (Bloomberg) That figure is roughly three times the 2015 number, indicating how rapidly P2P loans have become a material source of car purchase financing in China.
- Local car sales restrictions using license plate auctions and/or lotteries.
 - At least 7 Chinese cities now restrict the rate at which new cars can be registered in their jurisdictions. Shanghai runs a competitive auction for license plates, Beijing and Guiyang issue them through a lottery, and Guangzhou, Tianjin, Shenzhen, and Hangzhou issue plates through a combination of lottery and competitive bidding (Munoz-Garcia et. al.)
- Expanded public transit options, particularly subways and light rail
 - **If available mass transit makes transportation services more fungible, this may be a restraint on car use and could help explain the part of the growing gap between cars sold and incremental gasoline demand growth in China.**

Beijing's Subway Network Grew Dramatically Between 2008 and 2016

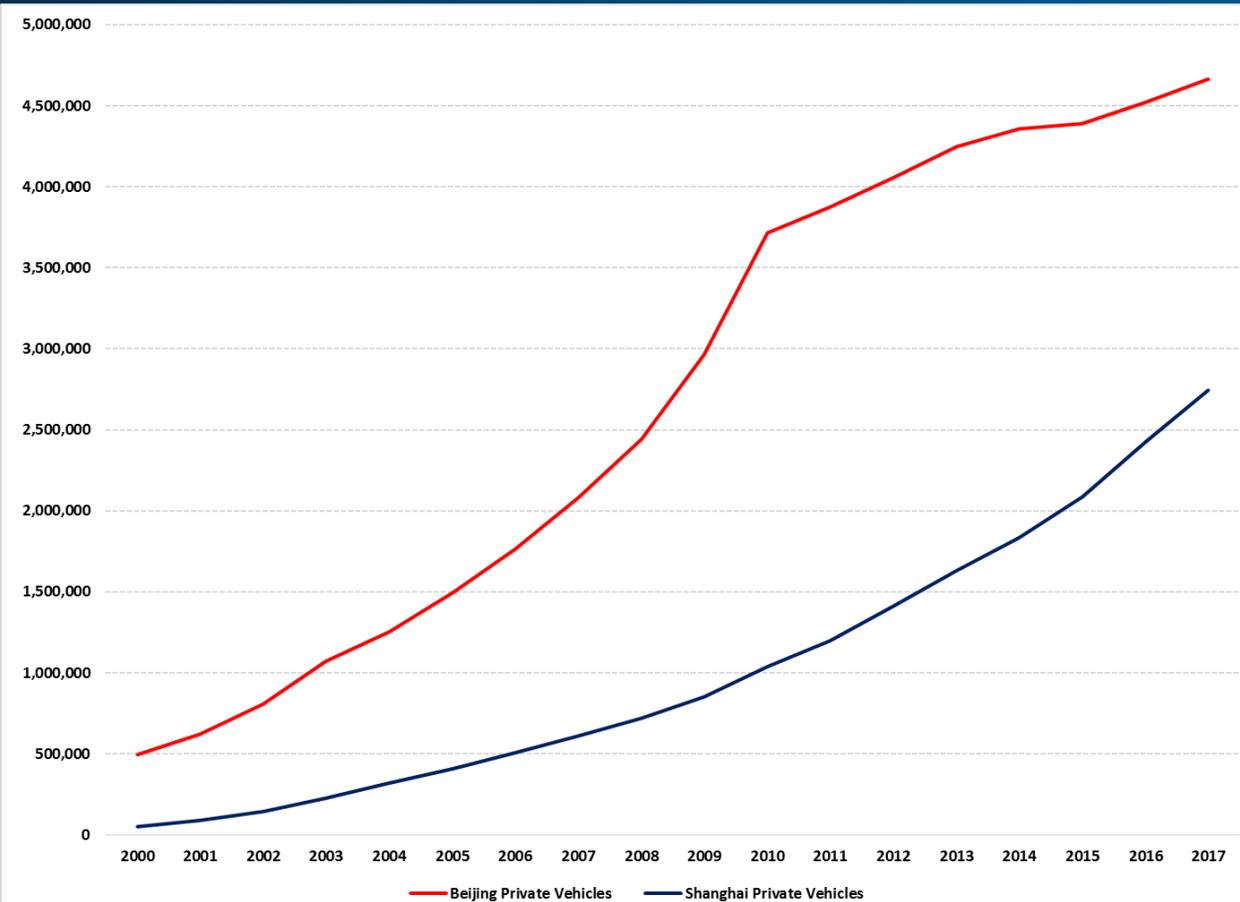


Between 2008 and 2016, Beijing's population rose by about 23%, while subway ridership increased by more than 150%.

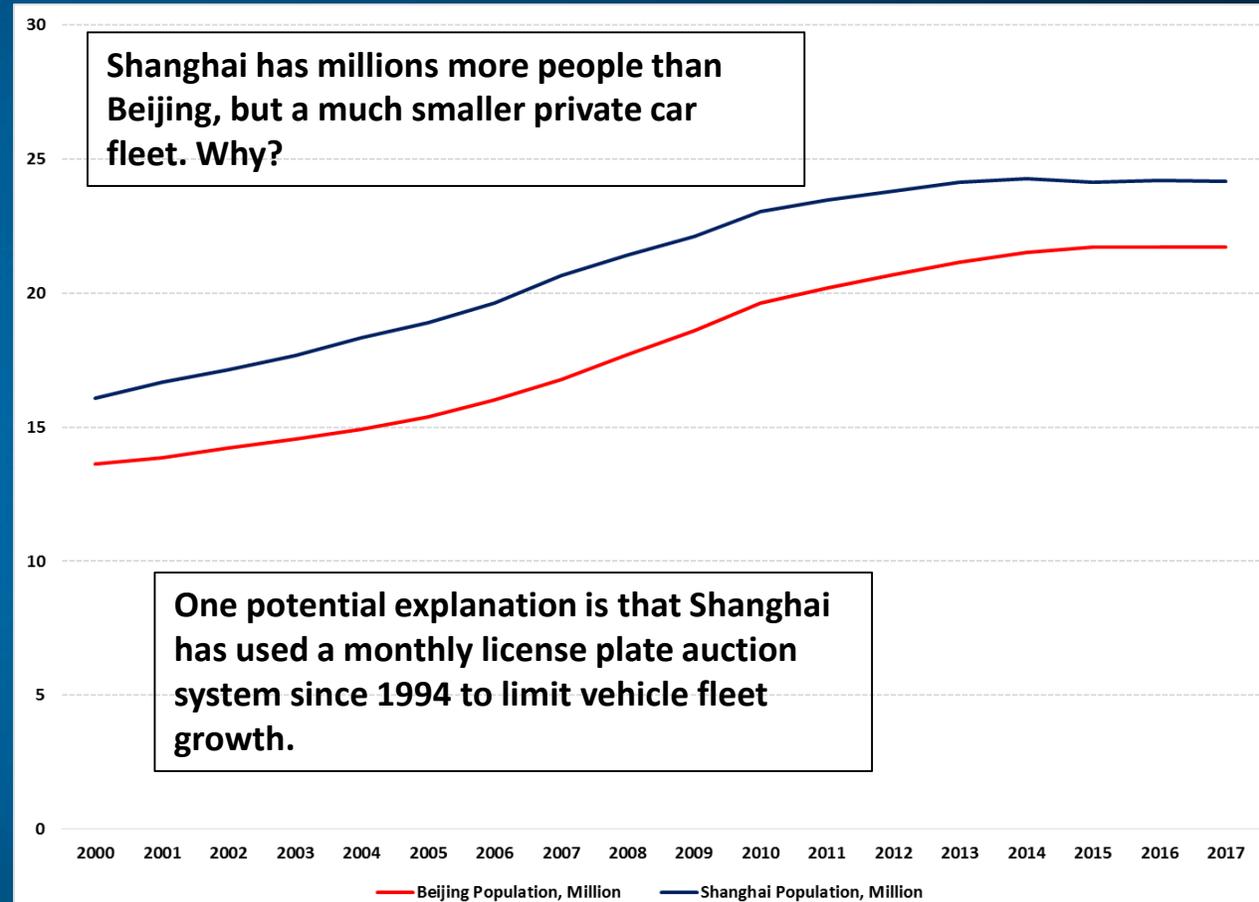
Source: Huffington Post(maps), NBS China (ridership and population data)

Beijing and Shanghai Vehicle Ownership Trajectories Illustrate Effects of Control Policies

Beijing and Shanghai Private Vehicle Fleet Size, Units

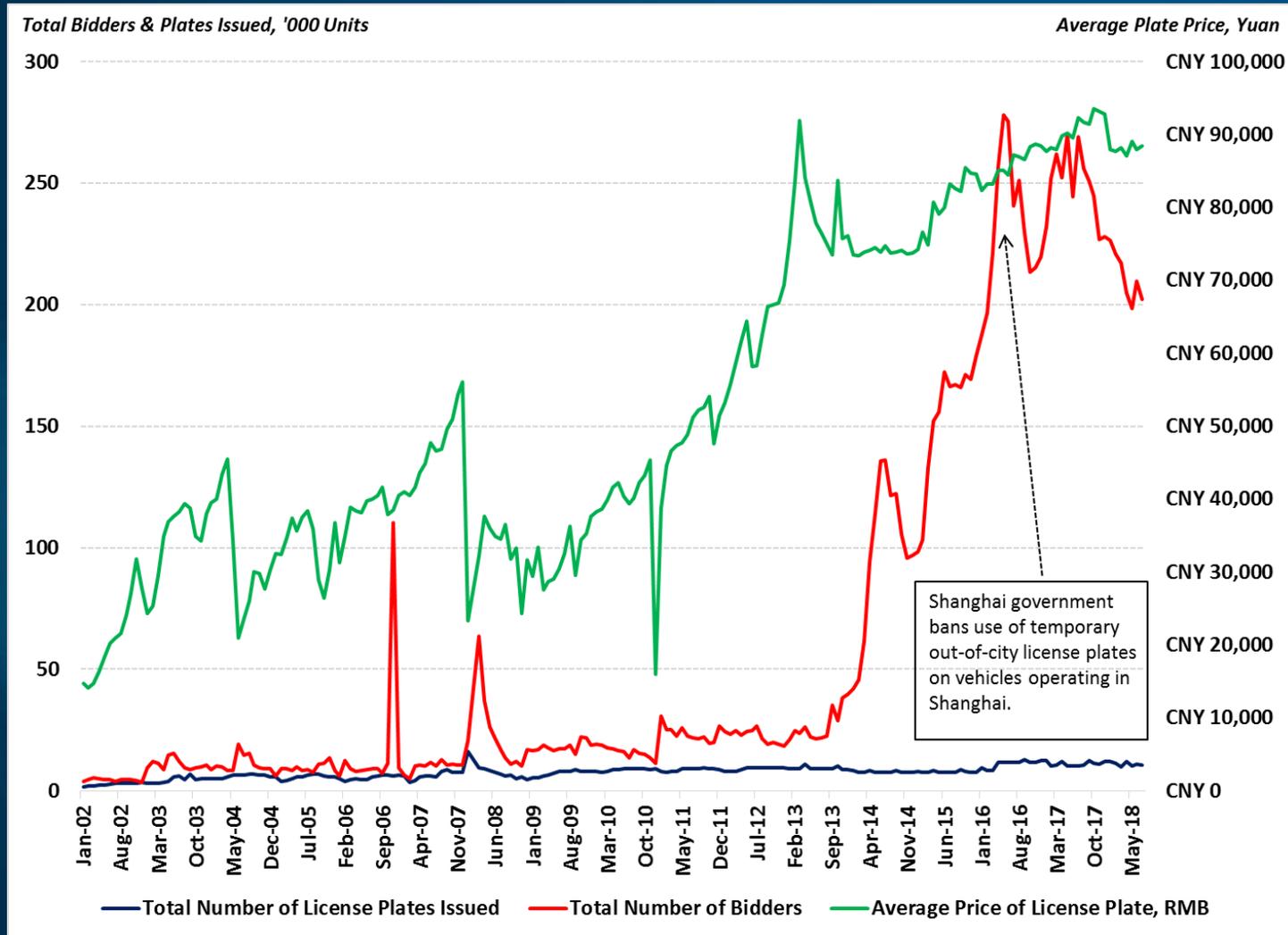


Beijing and Shanghai Population, Millions



License Plate Auction Data Suggest Pent-Up Demand for Vehicles is Colliding With Official Priorities

Shanghai License Plate Auction Price and Activity Trends



- ▶ The dramatic ramp-up of bidding activity and license plate prices over the past 5 years—and sustainment of the activity at a high level—suggests that if car buyers were left to their own devices, Shanghai’s vehicle fleet would be much larger than it currently is.
- ▶ But given strategic concerns at the national leadership level over oil import dependency and local air pollution, it is unlikely that the authorities will relax new vehicle registration quotas.
- ▶ Even if car sales were allowed to grow unfettered by any regulations in China’s largest cities, gasoline demand growth would still likely continue to slow as roads became more crowded and usage per vehicle declined as people sought other transport options. For many of these locales, additional road construction might not be able to materially reduce traffic congestion, especially over the longer term.
- ▶ A key question is whether smaller cities could offer a new pathway to renewed gasoline demand growth?

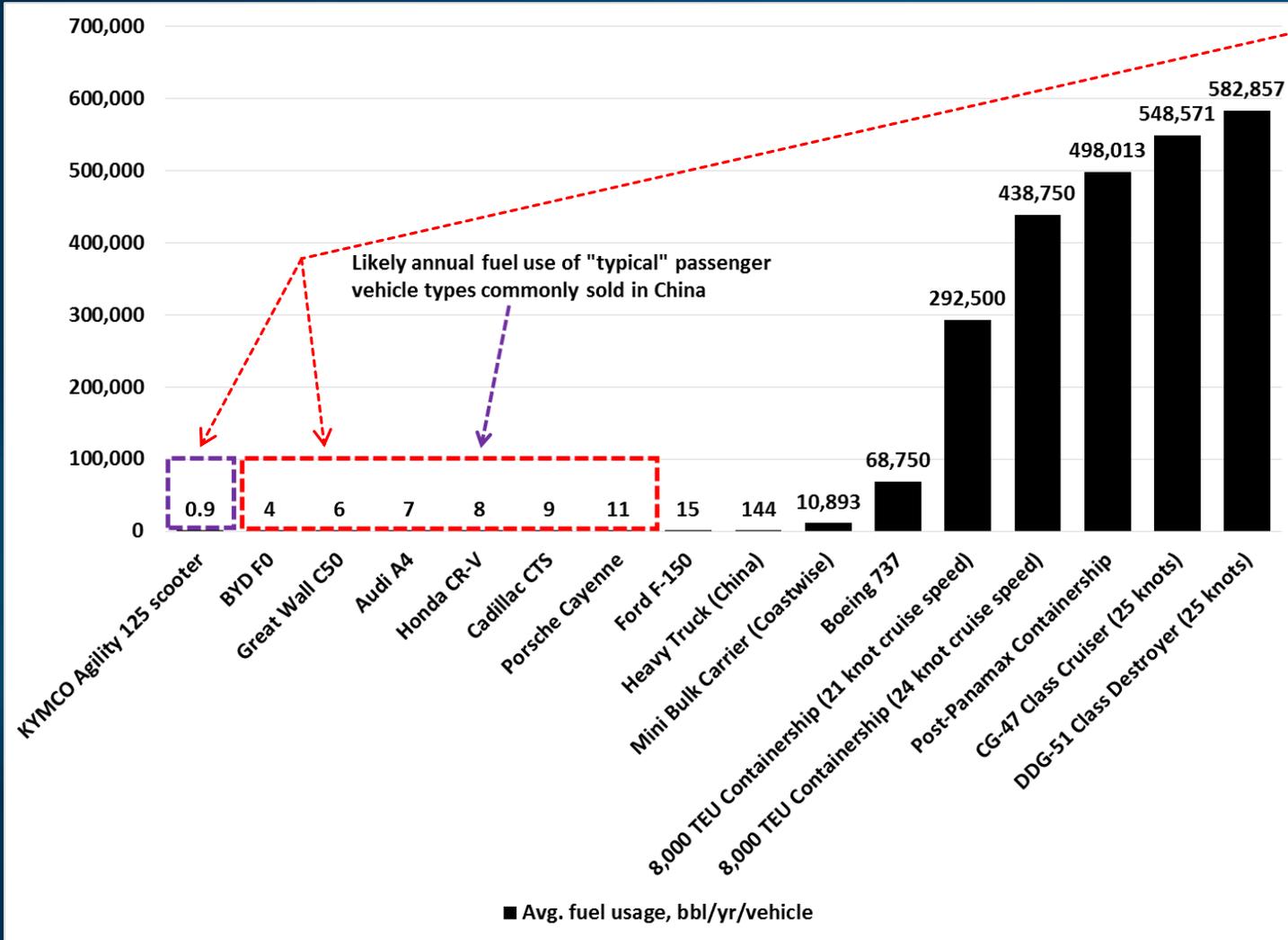
Dimension 4: What Is Powering Passenger Cars in China?

Propelling China's Car Fleet

- ▶ China's passenger car fleet remains dominated by gasoline engines.
- ▶ Approximately 0.3% of vehicles are diesel-powered (auto.sina.cn)
- ▶ EVs—including mini-EV models—likely account for somewhere in the range of 1.5% of the passenger vehicle fleet in China.
- ▶ With a total passenger car fleet approaching 200 million units and annual new passenger vehicle sales of approximately 24 million units, China's EV makers will need to scale up dramatically to achieve fleet turnover that materially increases EV's proportion of China's car parc in the next decade. Getting to a level where EVs are displacing a meaningful level of new car sales that otherwise would have gone to IC vehicles is a more achievable near-term target from a technical and financial perspective. If this level of new annual vehicle sales—somewhere north of 3 million EV units per year—could begin to meaningfully erode incremental gasoline demand growth.
- ▶ If pure battery EV sales grow alongside the continuing penetration of turbochargers, 48 volt propulsion assists, and other incremental drivetrain technology improvements, this could further curtail future gasoline demand growth. If the volume numbers can be sustained, a tipping point could come at which absolute gasoline demand volumes begin to gradually decline.
- ▶ Penetration of gasoline substitutes—addressed later in this analysis—could also reduce petroleum demand from China's transport sector. This could help fulfill the important national security priority of reducing oil import dependency, but perhaps at the cost of increased full-cycle emissions, particularly if coal-derived methanol comes to play a larger role in China's motor vehicle fuel pool.

Why Chinese Drivers' Decisions Matter for Global Oil Markets

Fuel Use, By Vehicle Type (gal/day)

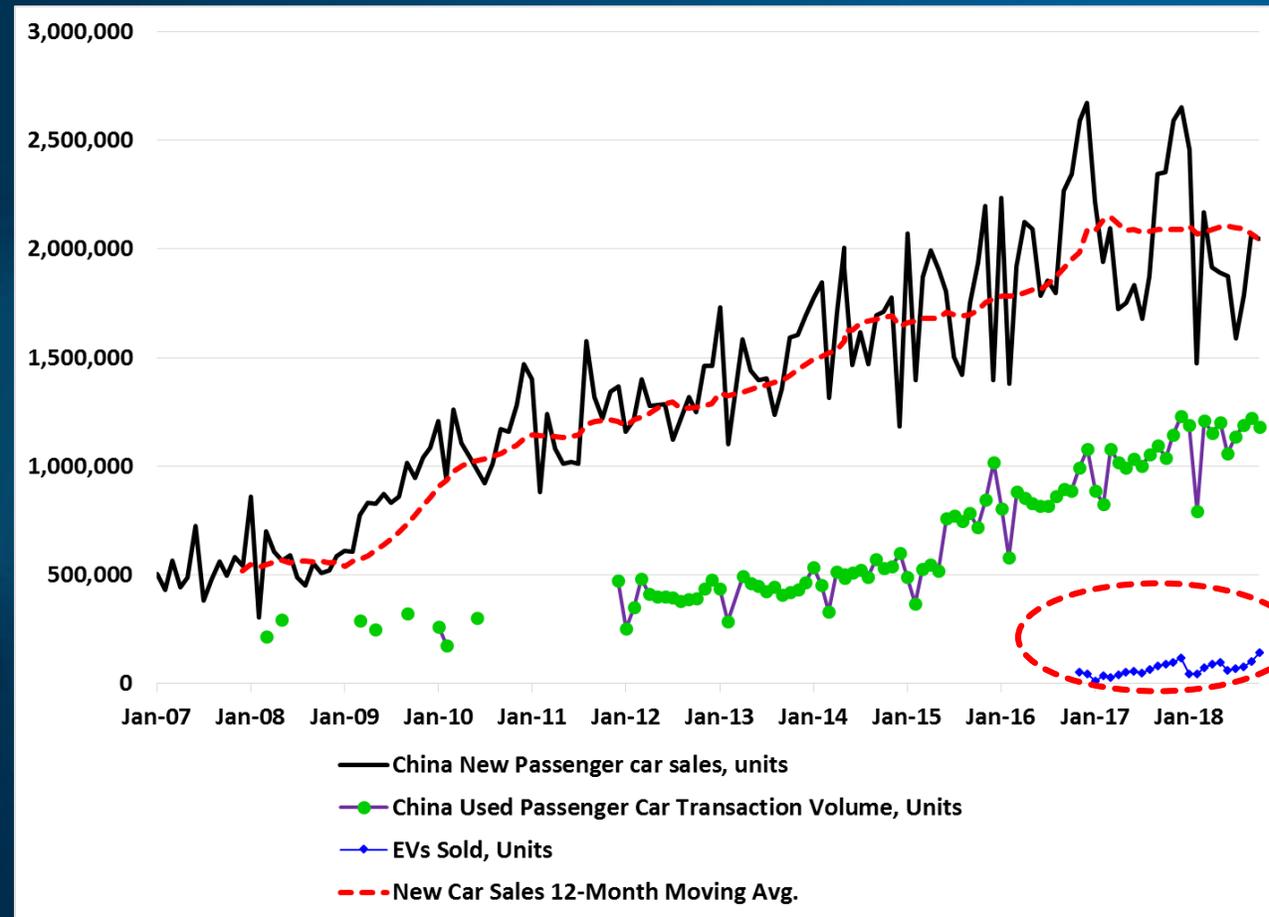


- ▶ Moving from a gasoline scooter to a mid-size car typical of many models sold in China increases a driver's gasoline use intensity by 5-10 times.
- ▶ But if the driver instead upgrades to an electric vehicle (or begins driving an EV instead of their current gasoline-powered car), significant potential gasoline demand growth is foregone.
- ▶ And the new EV occupies road space, potentially intensifying congestion and further souring drivers on either (1) buying a car or (2) using the one they already have as often as would otherwise have been the case.
- ▶ EVs in China raise environmental challenges, as in many cases they are effectively a "coal-to-road" proposition given the continuing preponderance of coal in China's power generation fuel slate. But regardless, they displace potential oil demand.
- ▶ If our hypothetical driver using the Kymco Agility 125 scooter switches to an EC3 compact electric car, somewhere between 0.5 and 1 gal/day of gasoline demand per day could be foregone. At "China-scale" (i.e. per million drivers) this could mean as much as 24 thousand bpd of potential lost gasoline demand. China's growing EV fleet is now likely just capturing potential new demand margin. How far are we from a turning point where EVs could more seriously erode gasoline demand growth?

Unpacking China's Electric Vehicle Story: The Impact of EVs

- Sales of “regular” EVs are trending upwards in China, with more than 720 thousand units sold in 2017 and nearly 800 thousand units sold in the first 10 months of 2018. But EVs are only small portion of the market and have a long way to go in order to exert a material impact on the overall Chinese car fleet and its energy use/emissions profile.

China EV Sales Compared To Other Motor Types (Units)



Source: CAAM, CPCA

Context Matters: 110 Years Ago, 1/3 of US Cars Were EVs



Source: Cleantecnica

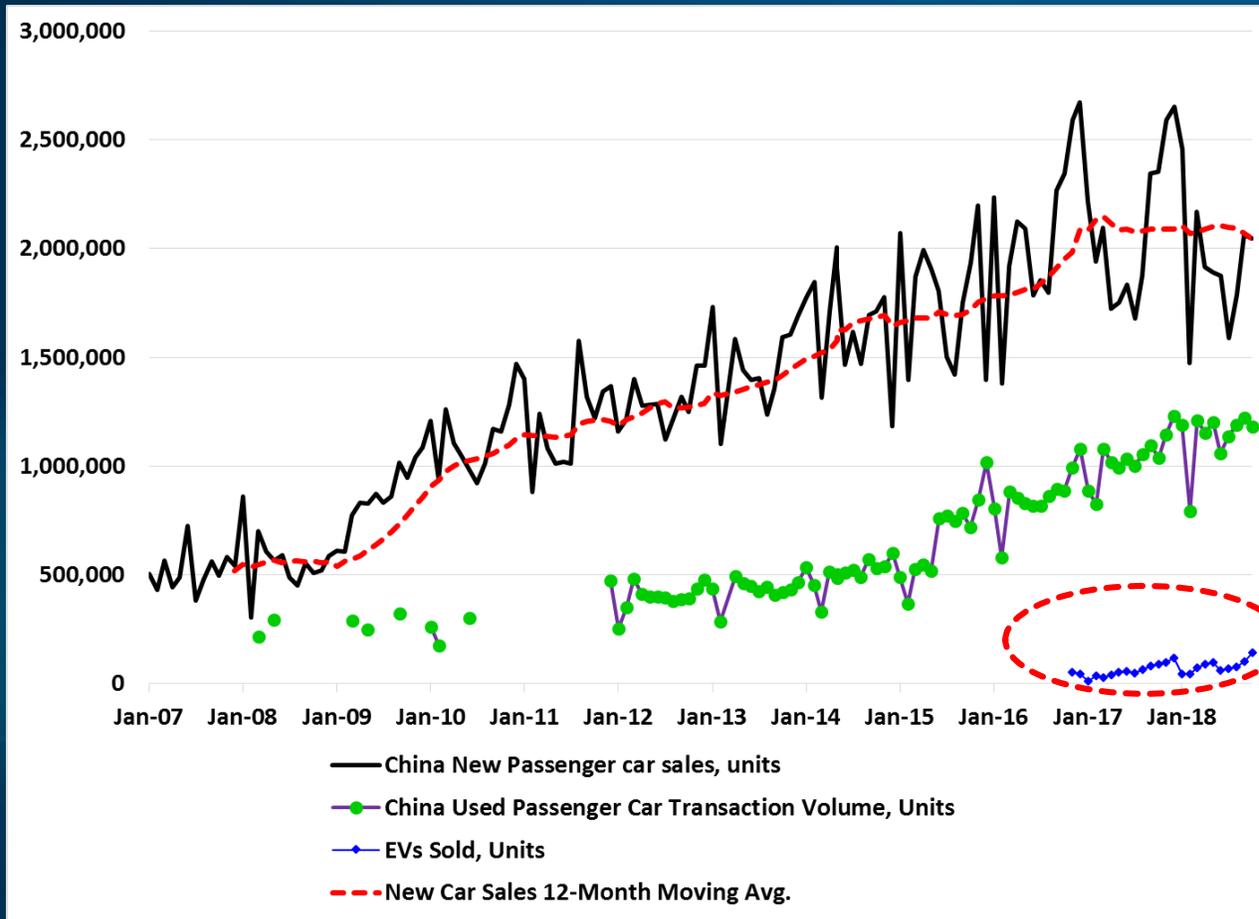
“The electric car has proven viable as a means for making long distance trips.”—The New York Times, 30 November 1908

But logistics were challenging...

“Despite his success in this matter, however, Mr. Fritchle says he doesn’t believe touring of the sort that he has just accomplished would be possible in an electric car to anyone but an expert electrician.”

Unpacking China's Electric Vehicle Story: The Impact of Mini-EVs

China Monthly Sales of New Cars, Used Cars, Electric Vehicles (Units)



- Sales of “regular” EVs are trending upwards in China, with more than 720 thousand units sold in 2017 and nearly 800 thousand units sold in the first 10 months of 2018.
- But an underappreciated story lurks—the booming demand for “mini-EVs.”
- As detailed in a September 2018 report in *The Wall Street Journal*, Chinese consumers may be buying *twice* as many of these tiny machines as they are regular EVs that are sized and priced similar to internal combustion cars sans the gasoline motor.
- The rub is that while a mini-EV may sell for as little as \$1,000, use primitive parts including lead-acid batteries, and often does not require a driver’s license to use, each unit sold and used can displace the gasoline consumption of a full-sized car.
- To put the gasoline market implications into perspective, 1.75 million mini-EVs entering the market (the 2017 China sales figure cited by the WSJ) could displace close to 40 thousand barrels per day of passenger car gasoline demand

Mini-EV in Gaotang, China

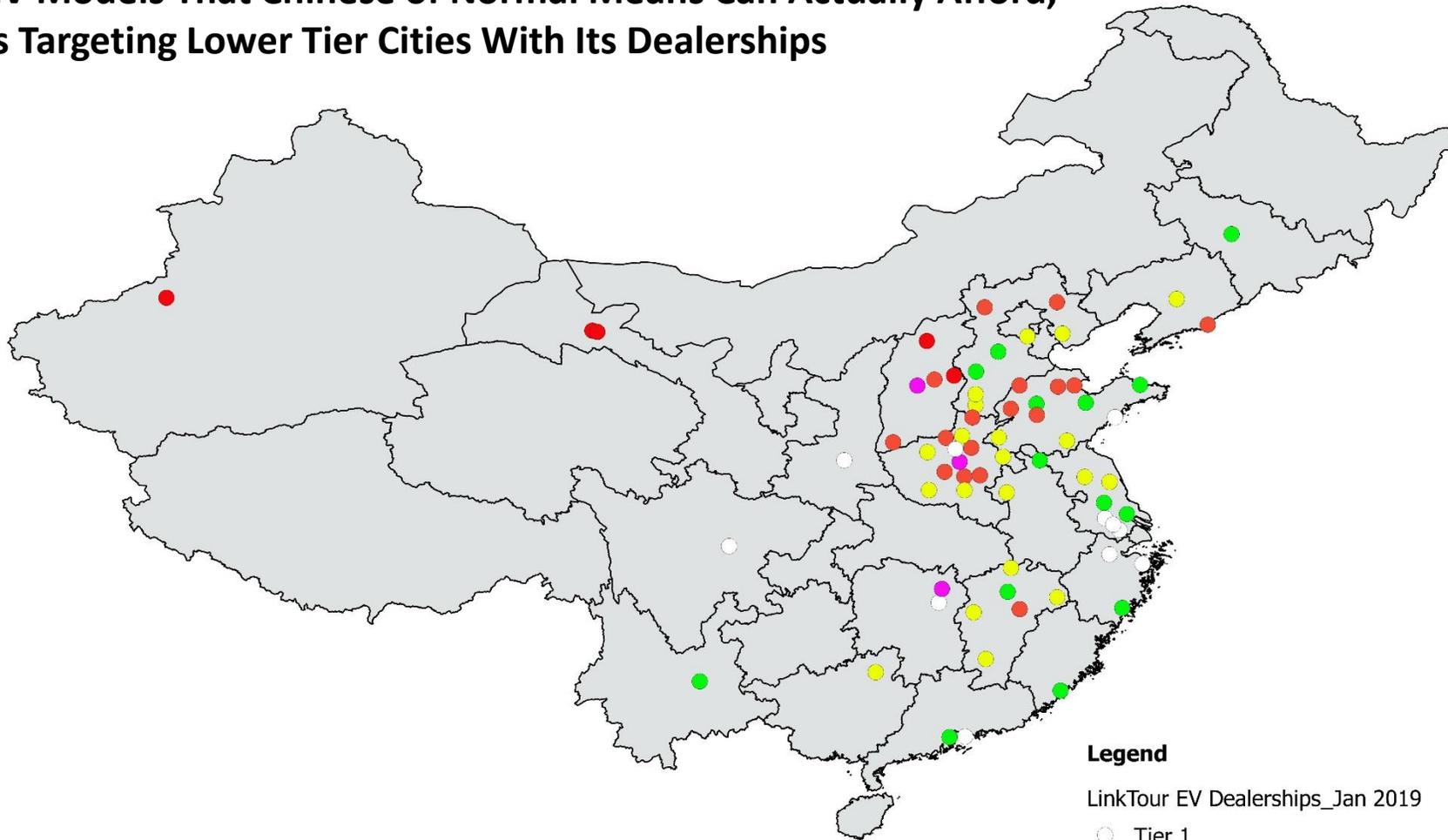


Source: Trefor Moss, The Wall Street Journal

Source: CAAM, CPCA

Mini-EVs Biggest Impacts May Come in China's Lower-Tier Cities

LinkTour (领途), One of China's Key Emerging Manufacturers of EV Models That Chinese of Normal Means Can Actually Afford, Is Targeting Lower Tier Cities With Its Dealerships



Legend

LinkTour EV Dealerships_Jan 2019

- Tier 1
- Tier 2
- Tier 3
- Tier 4
- Tier 5
- Tier 6

- ▶ NIO and Tesla grab the headlines with flashy bodies and brisk acceleration.
- ▶ But the majority of EVs that Chinese consumers can actually afford are more likely to come from carmakers like LinkTour, whose dealerships as of late January 2019 are mapped here.
- ▶ Lower-tier cities have the highest latent vehicle sales potential. A key question will be: “do prospective drivers make their leap into car ownership with smaller EVs and bypass gasoline entirely, do they use new EV models to replace older gasoline cars that they bought used, do they buy EV first and then switch to gasoline, or do electric and gasoline vehicles co-exist in many driveways?”

Can License Plate Fees Help Credibly Offset EV Subsidy Costs?

- ▶ EV adoption faces a number of technical challenges, including public charging capacity and what to do with batteries that have reached the end of their useful lives. Yet the economic sustainability of EV sales is an important issue as well given the significant subsidies used by the Chinese government to incentivize consumer purchases of EVs. The direct and indirect costs of EV subsidies are significant, and the financial challenges would likely scale up in a linear fashion along with rising EV sales unless manufacturers can bring down costs.

Direct Subsidies for EV Purchases in Beijing, Shanghai, Guangzhou, and Shenzhen

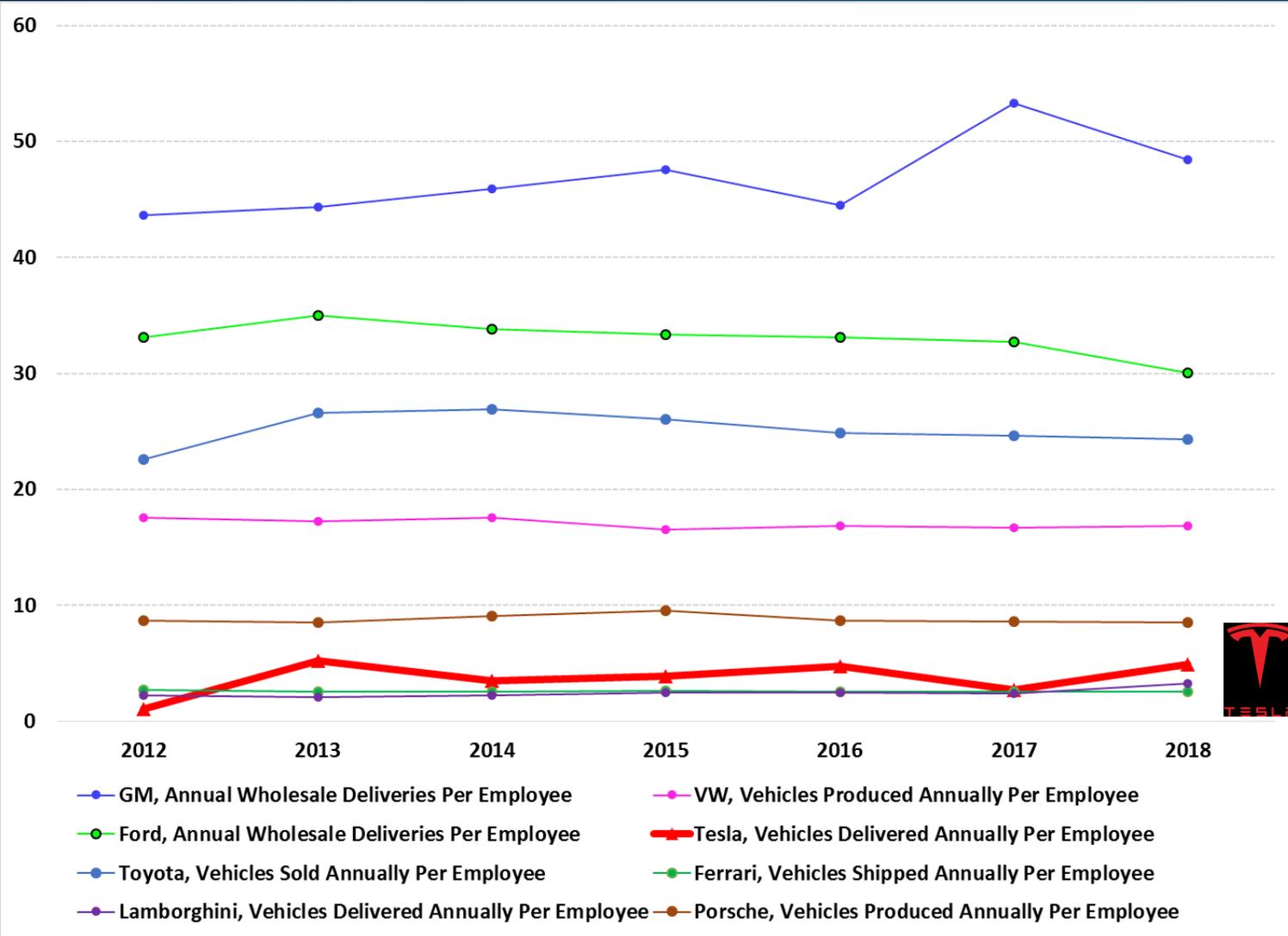
		EV Range Between 100km and 150km	EV Range Between 150km and 250km	EV Range Greater Than 250km	Other Supportive Policies
Beijing	Central Govt. Subsidy	CNY 25,000	CNY 45,000	CNY 55,000	Exemptions from the purchase tax and license plate lottery, exemptions from driving restrictions
	Local Govt. Subsidy	CNY 25,000	CNY 45,000	CNY 55,000	
	Total Govt. Subsidy	CNY 50,000	CNY 90,000	CNY 110,000	
Shanghai	Central Govt. Subsidy	CNY 25,000	CNY 45,000	CNY 55,000	Free license plates for EVs
	Local Govt. Subsidy	CNY 10,000	CNY 30,000	CNY 30,000	
	Total Govt. Subsidy	CNY 35,000	CNY 75,000	CNY 85,000	
Guangzhou	Central Govt. Subsidy	CNY 25,000	CNY 45,000	CNY 55,000	Exemptions from the vehicle tax and license plate lottery, exemptions from driving restrictions
	Local Govt. Subsidy	CNY 25,000	CNY 45,000	CNY 55,000	
	Total Govt. Subsidy	CNY 50,000	CNY 90,000	CNY 110,000	
Shenzhen	Central Govt. Subsidy	CNY 25,000	CNY 45,000	CNY 55,000	Subsidies for charging stations, preferential electricity prices and parking fees
	Local Govt. Subsidy	CNY 35,000	CNY 50,000	CNY 60,000	
	Total Govt. Subsidy	CNY 60,000	CNY 95,000	CNY 115,000	

Source: Boqiang Lin et.al

- ▶ In key cities such as Shanghai, the average price per license plate auctioned for internal combustion vehicles can approach 90 thousand RMB. This number far exceeds the 25-to-55 thousand RMB in subsidies per vehicle that the local government could find itself obligated to pay.
- ▶ But viewed more holistically, the arithmetic is less favorable. If the government in Shanghai could have auctioned a license plate for 90 thousand RMB to a gasoline car owner in a highly competitive marketplace, but waives the plate fee for an EV owner whose vehicle counts against the monthly quota of plates issued *and* provides at least 25 thousand RMB in subsidies, one could argue the true net cost of a single EV to local coffers could in fact be 115 thousand RMB or more (115 billion RMB per million vehicles, or about 16% of Shanghai's 2018 municipal budget).

Potential Barrier to EV Scale-Up: Carmaker Productivity

Carmaker Productivity: Vehicles Produced (or Sold*) Annually, Per Employee



	Vehicles produced in 2018 per Tesla produced
GM	95.0
Ford	65.4
Toyota	88.8
VW	106.3
Porsche	2.5
Lambo	<1
Ferrari	<1

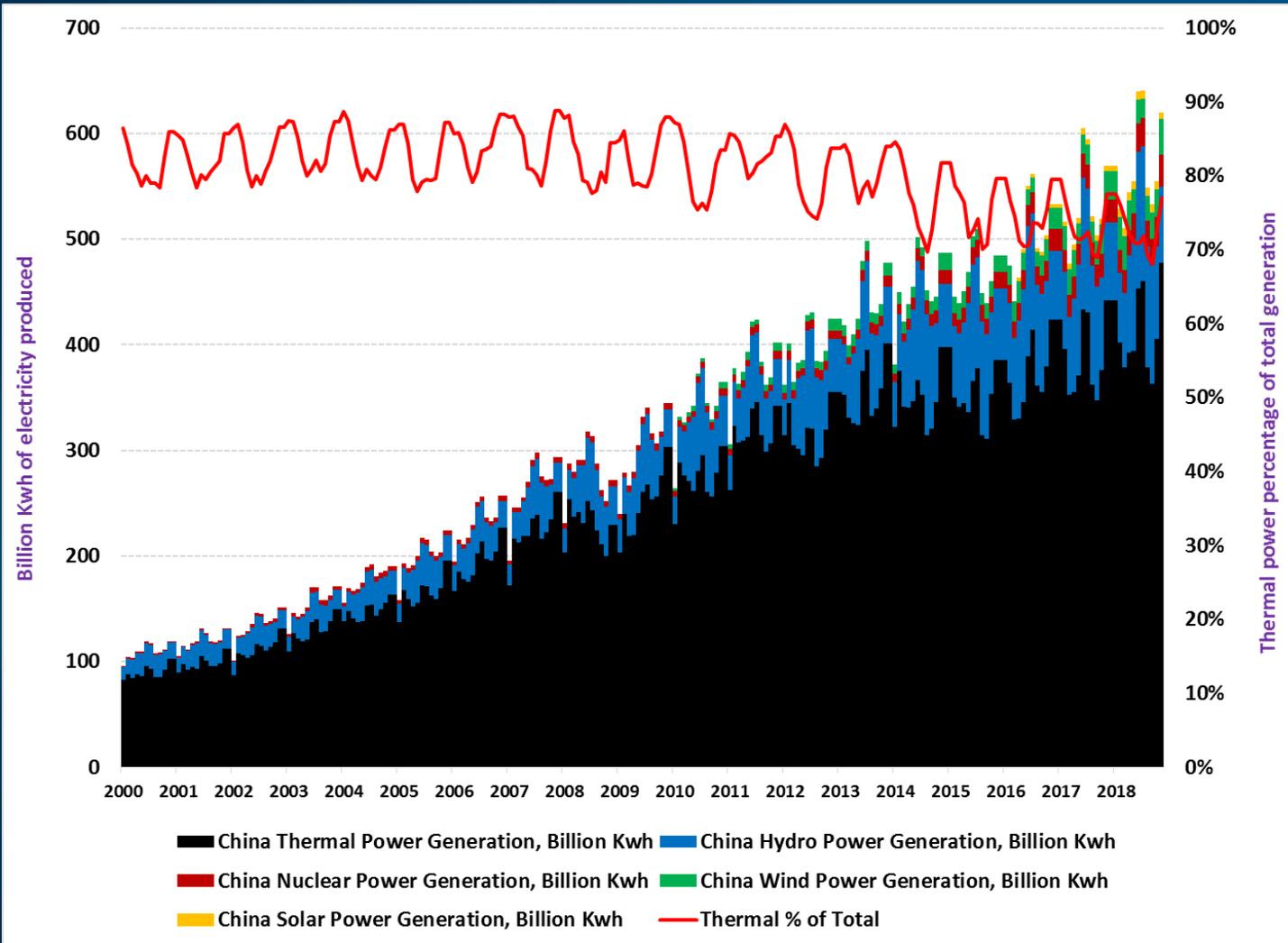


In plainest terms, Tesla is trying to sell mass market cars with scale and production efficiency rates somewhere between Porsche and the exotic supercar makers.

*Note: I sought actual production data to the extent I could locate them. Sales and deliveries data generally closely track the production numbers at the large carmakers and are a reliable proxy for measuring manufacturing activity. At Toyota, for instance, the difference between the two numbers in FY 2017 was only 1.2% (the margin by which sales exceeded production).

Risk Factor: Are EVs in China Simply Trading “Oil Security” For “Air Security”

Thermal Power—Primarily Coal—Remains China’s Dominant Electricity Source



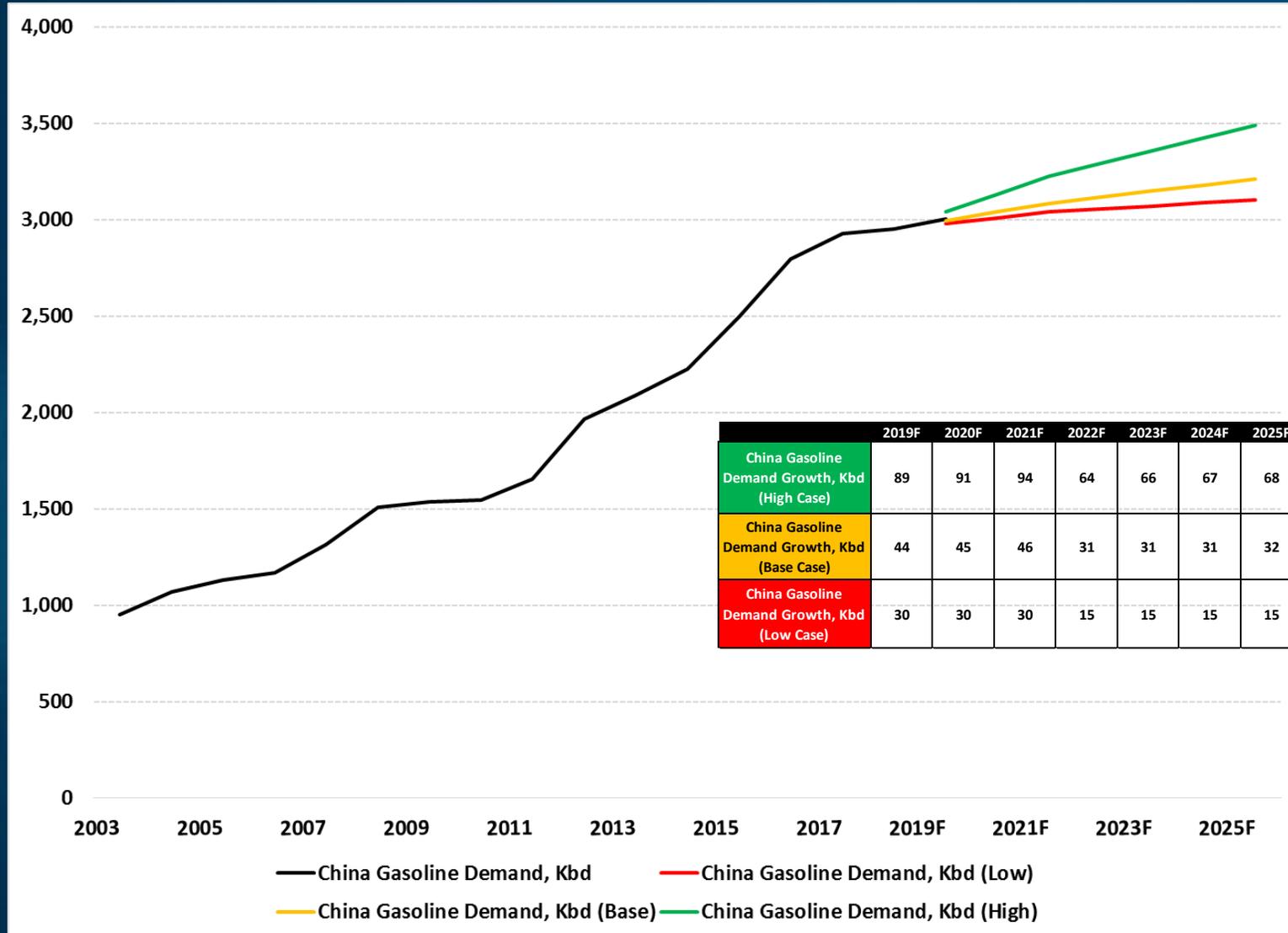
Source: Bloomberg, Author’s Analysis

- ▶ Despite the rapid growth rate in wind and solar generation capacity, China still relies overwhelmingly on coal-fired plants to generate its electricity. As such, electric cars simply shift pollution problems from a semi-dirty vehicle tailpipe to a potentially much more emissions-intensive power plant smokestack.
- ▶ Each million plug-in electric passenger cars would likely create an additional 740,000 tonnes per year of coal demand in China—equivalent in CO2 emissions terms to approximately one million BYD F0 gasoline-powered passenger sedans. In this sense, a pure plug-in electric car running on grid power in many parts of China (aside from areas where grid supply comes primarily from hydro or nuclear plants) is effectively still as carbon intensive as a fully gasoline-powered compact car, virtually negating the environmental benefits of going full electric. Moreover, burning coal also releases far more sulfur than burning an equivalent amount of gasoline, not to mention mercury and other toxics not typically emitted in meaningful amounts by gasoline engines.

Gabriel Collins, "China's Evolving Oil Demand: Slowing Overall Growth, Gasoline Replacing Diesel as Demand Driver, Refined Product Exports Rising Substantially." (2016), <http://www.bakerinstitute.org/research/chinas-evolving-oil-demand/>.

Quantifying EV Impacts on Gasoline Demand

China Average Annual Gasoline Demand (Historical + Potential Scenarios), '000 bpd



- ▶ How would rising levels of EV penetration into the Chinese car fleet potentially impact gasoline demand?
- ▶ EVs could capture incremental gasoline demand growth. Assuming the average Chinese driver travels 12,000 km/yr and that the “average” Chinese car’s fuel economy is 6.5 liters/100km, that driver would use 780 liters of gasoline annually (4.9 barrels). Thus, replacing one million such vehicles with pure battery EVs could theoretically displace about 13 kbd of gasoline—slightly over ¼ of the anticipated incremental demand growth in the Base Case of this analysis.
- ▶ As such, assuming the usage and fuel economy parameters described above, the entry of 4 million new pure electric vehicles per year into the Chinese car fleet could potentially offset all incremental gasoline demand growth. Even in the high-growth gasoline demand scenario shown in this slide, EV sales at the 4 million units/year level could still grab half of potential incremental gasoline demand growth.

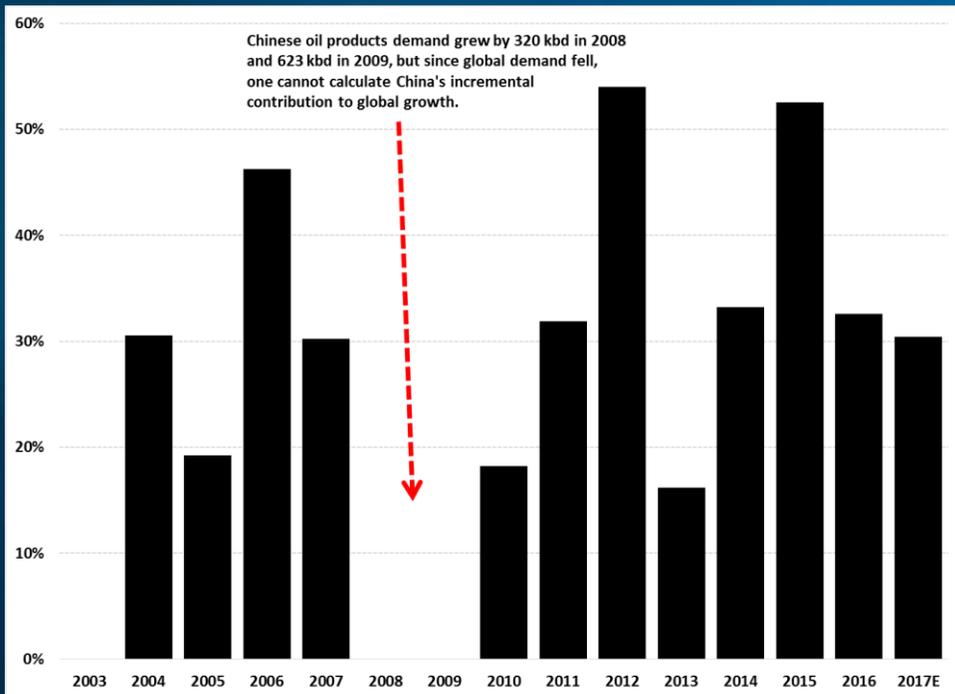
But Could Gasoline-Driven Crude Oil Demand Be “Rolled Back”?

- ▶ The question of whether China’s gasoline demand gets “rolled backwards” will critically depend on how policymakers at the national, provincial, and city levels choose to balance the externalities of continued reliance on petroleum-derived gasoline versus the externalities of investing in electric vehicles, public transport, and alternative liquid fuels aimed at displacing “traditional” gasoline.
- ▶ A holistic accounting of EV subsidy costs that includes foregone license plate sale and auction revenues, as well as the more traditional purchase price subsidies places the government-borne cost of an EV that can drive 250km or more per battery charge as high as 200,000 RMB per vehicle. Accordingly, placing 25 million EVs into China’s passenger vehicle fleet—enough to replace slightly more than 10% of the current total fleet—could cost 5 trillion RMB, or nearly 6 times Shanghai’s 2018 total government budget (Caixin). Shanghai is used as a comparison because it is one of China’s largest economies and because larger and wealthier cities are where the burden of the high-subsidy EV boom will likely disproportionately fall.
- ▶ The x-factor in this EV cost assessment is if Chinese consumers opt for smaller, micro-style EVs and manufacturers can meet the demand call.
- ▶ Another wild card is government subsidy policy. The PRC central government is now reducing EV subsidies to try and rationalize the sector by chasing out low-quality, low-volume producers. The government likely also realizes that scaling the sector under the current financial architecture would be unsustainable.
- ▶ Gasoline demand can also be negatively impacted if the government supports greater use of methanol (typically coal or natural gas-derived) as well as ethanol (typically grain-derived). But putting more coal and corn into Chinese drivers’ gas tanks brings potentially significant environmental, financial, and food security costs.

Strategic Implications of Stagnating—or Eroding—Domestic Gasoline Demand in China

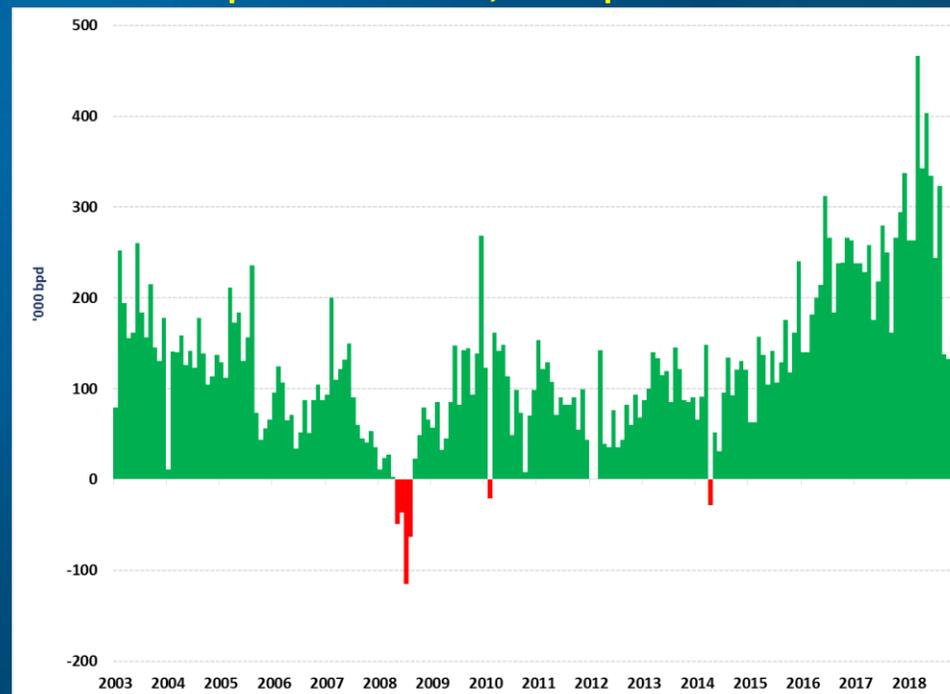
- ▶ Can other oil consumers compensate for lost Chinese demand? Depressive effect on crude prices likely.
- ▶ China remains a world-scale exporter of gasoline
- ▶ Chinese policymakers could actually be tempted to redouble oil displacement initiatives
 - ▶ Additional EV support
 - ▶ Greater use of methanol in gasoline pool
 - ▶ Greater inclusion of ethanol in gasoline pool

China % of Total Incremental Global Oil Products Demand Growth



Source: BP Statistical Review, 2018

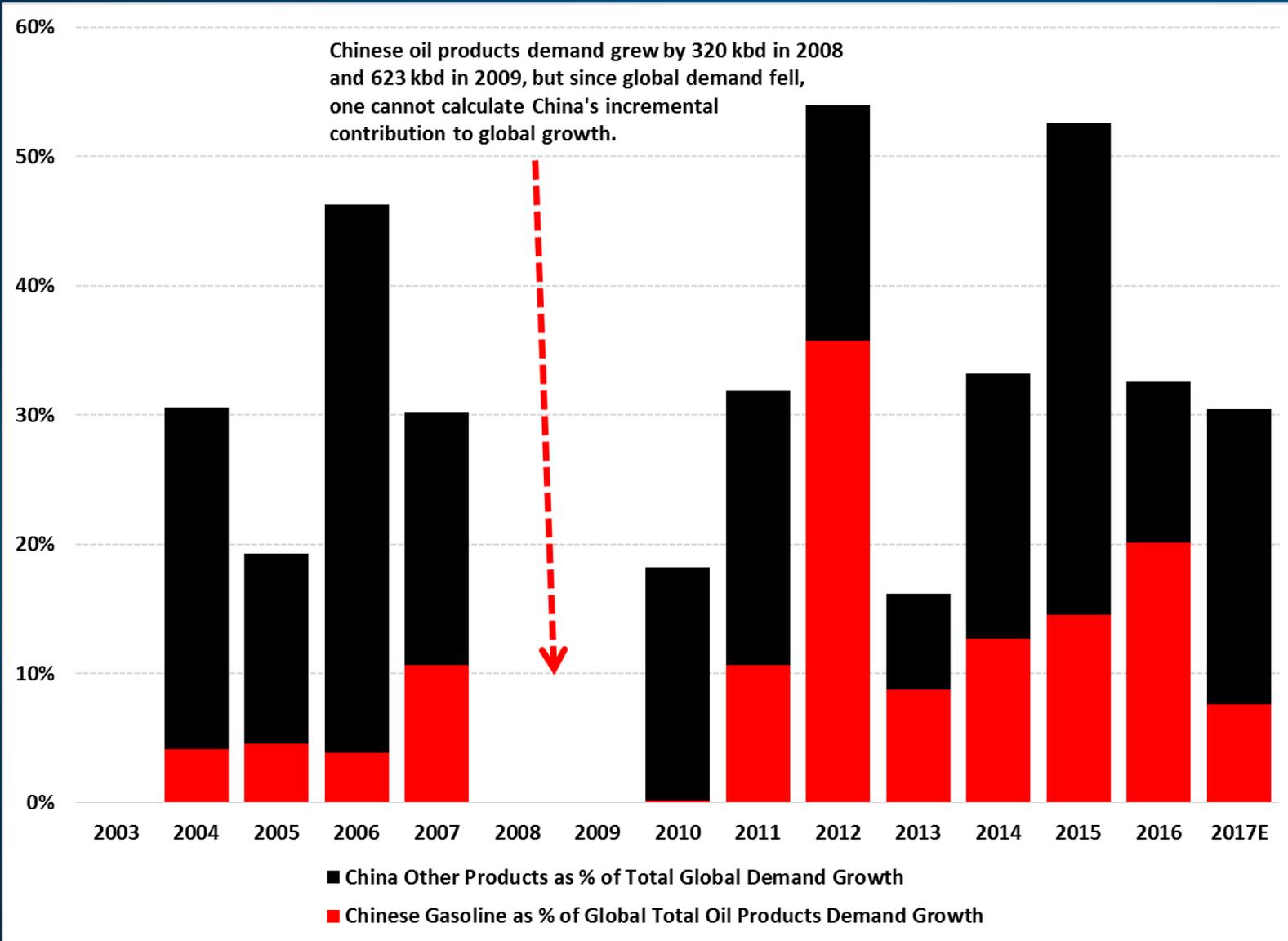
China's Net Exports of Gasoline, '000 Bpd



Source: JODI

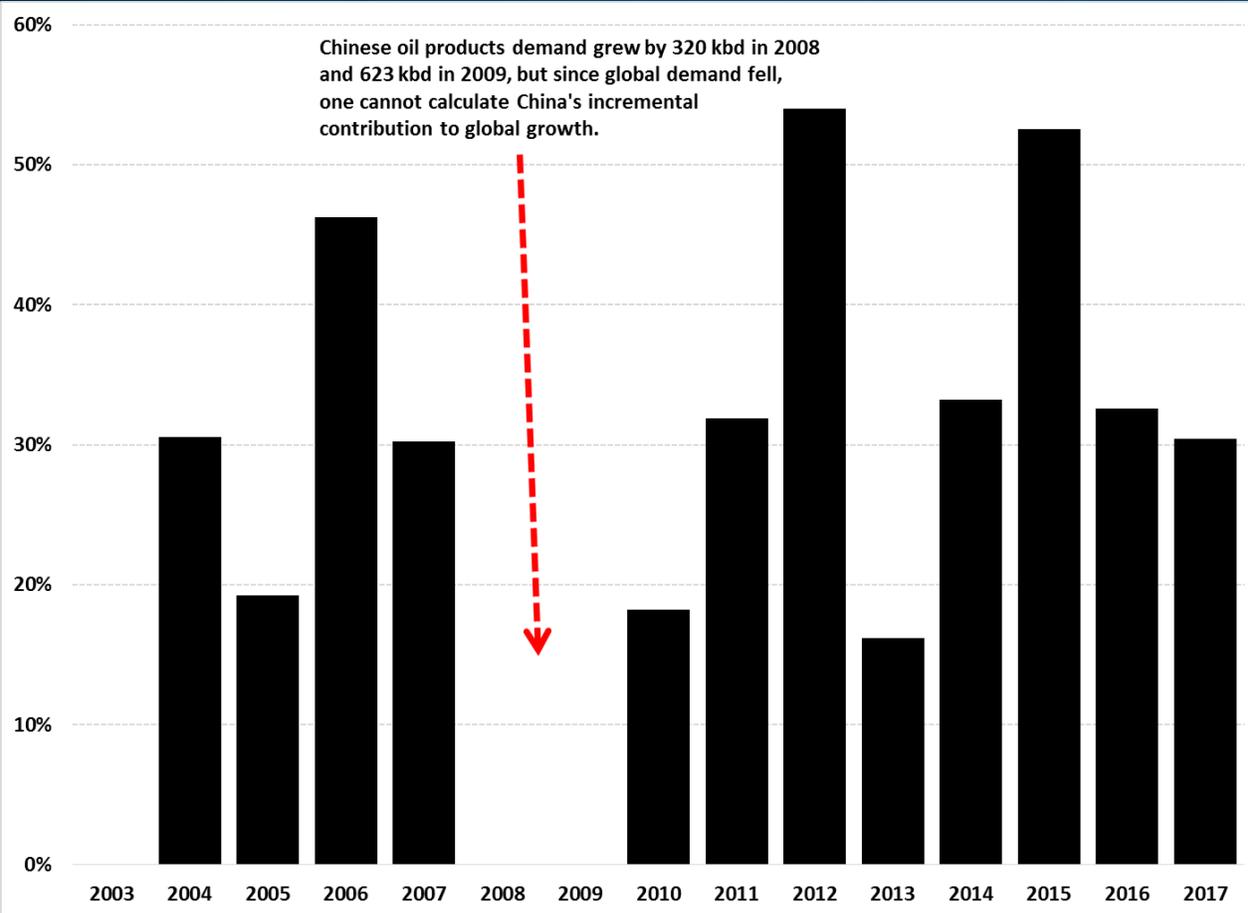
How Does China's Gasoline Demand Trajectory Potentially Impact Global Oil Markets?

China's Gasoline Demand Becoming Less Important as Driver of Global Oil Products Use



Credible Replacements for Chinese Oil Demand As a Growth Driver?

China % of Incremental Global Oil Demand Growth



Source: BP Statistical Review 2018, IEA OMR

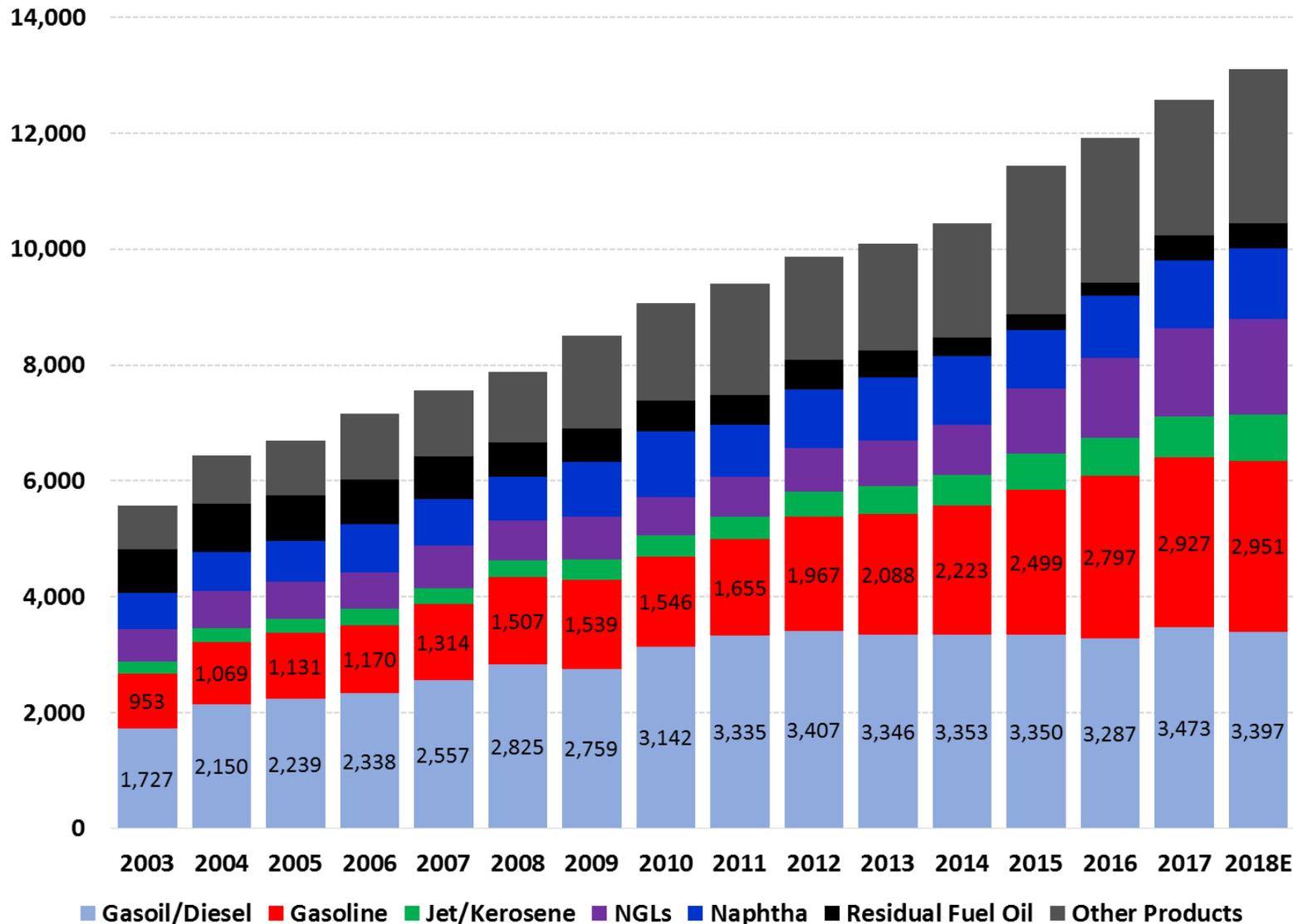
India % of Incremental Global Oil Demand Growth



Source: BP Statistical Review 2018, IEA OMR

China's Oil Demand Outlook: Macro Take

China Oil Products Demand, By Type ('000 Bpd)



- China's oil products use remains highly transportation-centric
- Petchems have driven growth in NGL and naphtha demand.
- The scope for further growth in domestic demand for petchems—particularly plastics—and the associated feedstocks will be important from at least two core perspectives.
 - First, an increasing volume of the NGLs feeding plants in China actually originate in US shale plays and are not “crude oil-derived,” per se (Collins 2017).
 - Second, per capita demand for key plastics (polyethylene and polypropylene) in China's wealthier coastal markets is already at or above OECD levels (Richardson 2018). Inland provinces will thus be pivotal players in determining how much domestic growth runway remains—and with it, the latent potential for NGL and naphtha demand.

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