Researcher probes the future of transportation in China

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Some policy analysts worry that if per capita wealth in China continues to escalate and approaches that of the United States, automobile ownership could quadruple. The likely consequences: extreme traffic congestion and even higher concentrations of air pollution and planet-warming carbon emissions. But researchers are all over the map as to how much massive increases in personal wealth in China will impact private car ownership levels and vehicle travel. Complicating their estimates are vast regional differences in economic growth rates; the emergence of vehicle ownership restrictions in some of China's most densely populated cities; and common, yet unproven, assumptions that China's car ownership growth will resemble that of the U.S., South Korea, and other countries during periods of rapid economic expansion.

Since 2012, Paul Natsuo Kishimoto, a research assistant in the MIT Joint Program on the Science and Policy of Global Change, has been applying new data sources and analytical methods to get an accurate read on how vehicle ownership and mileage are likely to change in China in the coming decades, and the costs and benefits of vehicle ownership restrictions. Using household survey data and public statistics on different Chinese cities, Kishimoto is working to characterize the relationship between rising income and transportation-related consumption, and how vehicle ownership restrictions would alter that relationship.

"What we're trying to do is to use data sources and methods that other people have not used, and that are more flexible and sophisticated, to do

this estimation," says Kishimoto, who is pursuing this research in preparation for his PhD thesis for the Engineering Systems program within the MIT Institute for Data, Systems and Society (IDSS). "Our goal is to determine how much people spend on private vehicles as a fraction of their income; how that changes as their incomes rise, public transit options emerge, and vehicle ownership restrictions are imposed; and how these transportation choices are likely to impact the nation's energy use, greenhouse gas emissions, and air pollution levels."

The research could inform policymakers not only in China, but also in other developing countries where rapidly rising incomes could translate into considerably more cars on the road.

Kishimoto comes to this work as a result of his own experiences of living with—and without—access to a privately-owned automobile. Growing up in the suburbs of Toronto, he first saw himself as a "math nerd" with an affinity for fighter jets and dreams of building far-out, futuristic aircraft. As a preteen, he announced to his parents, both math teachers, his intention to become an aerospace engineer. Later, as an aerospace engineering major at the University of Toronto, he expected to realize his childhood dream, but the experience of living in a city for the first time altered his flight path.

"It was revelatory that you didn't need a car to get everywhere," he recalls. "I had not given much thought that there was another way that your life could be organized other than having mom and dad drive you everywhere, borrowing a vehicle or getting picked up, or, perhaps, not going to certain places at certain times. In the city you just walk out the door, get on a bike or get on transit; things are within walking distance. I started realizing that this was a consequence of planning decisions, of policy. That in the suburb where I had grown up, somebody had made a choice at some point that we're going to build subdivisions instead of building a dense urban form that's more walkable and livable."

As Kishimoto completed his bachelor's degree in aerospace engineering and commenced work on a master's, this realization—alongside a growing interest in sustainability and climate change—began to take center stage. Anticipating a career that would not likely offer opportunities to work directly on such concerns, he made a course correction. He left the master's program, sought out a course of study that reflected his appreciation for the value of applying scientific and technological expertise to decision-making—from municipal transportation planning to global climate policy—and found it in the MIT Technology and Policy Program (TPP).

From 2010 to 2014, both during and immediately after completing his TPP master's program, Kishimoto worked as a research assistant and associate at MIT. After a one-year stint working on a classroom-oriented version of the Integrated Global System Modeling framework, he began collaborating with the Joint Program's China Energy and Climate Project leader Valerie Karplus (now an assistant professor at the MIT Sloan School of Management) on developing the China Regional Energy Model (C-REM) model, which projects energy demand and its associated environmental impacts in China under different policy scenarios. Once accepted to the MIT Engineering Systems program as a PhD candidate, he continued this work with a focus on adding representation of household transportation to C-REM, all while co-authoring two journal papers on the environmental, climate, and economic impacts of global and Europe-based fuel economy standards.

"The future growth of China's household vehicle fleet is one of the greatest sources of uncertainty in energy and environmental impact scenarios," says Karplus. "Paul is one of the few scholars piecing together novel sources of data on consumer behavior to quantify the underlying drivers of this growth. His results have the potential to change the way stakeholders approach the design of China's urban transportation systems in the coming decades."

In the past two years, Kishimoto has served as a Joint Program research assistant while developing his PhD thesis on modeling the future of transportation in China and its potential environmental and climate impacts. His work applies innovative analytical methods to myriad data—on the country's fast-growing economy, burgeoning wealth, rapidly expanding transportation infrastructure, and assortment of transportation policies—to project how China's transportation system is likely to evolve in the next few decades. Such knowledge could empower decision-makers to steer China's transportation future—and that of other developing countries—in a more sustainable direction.

"Compared to the developed world, the state of transportation systems in China is less well-understood, and because it's such a large, populous country, unrestricted or poorly guided growth could lead to significant negative consequences for the environment and climate," says Kishimoto. "That's why we're engaged in the work we're doing. We're trying to apply innovative methods, including those developed at the Joint Program, and combine datasets in novel ways to get a better understanding of how transportation will evolve in China, and the kinds of regional and global impacts that may result if no corrective policy action is taken."

After earning his PhD (most likely by the end of 2017), Kishimoto hopes to return to Canada and start a program much like TPP—graduate education for engineers and scientists on connecting technical knowledge to policymaking. He sees this education as increasingly important not only for policy wonks who lack a science and engineering mindset, but also for scientists and engineers who need to better understand the societal implications of their innovations. Drawing on extensive leadership and teaching experiences at the University of Toronto and MIT, Kishimoto envisions spearheading a Canadian version of TPP while serving as a faculty member focused on transportation, energy, and policy analysis.

He also plans to continue, as is his wont, to engage people in conversations about transportation and its impact on the quality of their lives, the environment, climate, and other societal concerns.

"I encourage them to think about transportation not just on a day-to-day basis, but in terms of systemic issues and how they can contribute to the broad changes needed to take us toward sustainability."

More information: Paul Kishimoto et al. Modeling Regional Transportation Demand in China and the Impacts of a National Carbon Policy, *Transportation Research Record: Journal of the Transportation Research Board* (2014). DOI: 10.3141/2454-01

The Impact of Coordinated Policies on Air Pollution Emissions from Road Transportation in China: globalchange.mit.edu/research/publications/2991

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