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A Risk Modeling Framework for Autonomous Vehicle Technology

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Today's autonomous motor vehicle technology ranges from collision avoidance and adaptive cruise control systems (both currently available) to driverless cars and platoons of vehicles driving together automatically in close proximity. The vision for the future is vehicleinfrastructure integration, in which vehicles are networked to their surroundings, namely, to each other, traffic signals and the roadway itself. The adoption of these systems will likely reduce auto insurance losses because fewer losses will result from driver error. But product liability insurance losses are likely to increase as technology takes greater responsibility for driving decisions. Since product liability claims are typically much larger than auto claims, the result will be a heavier-tailed overall loss distribution.

We develop a framework for quantifying tail risk. Since direct experience data will not be available for many years, we follow the structural approach (pioneered in catastrophe modeling) of building the model out of the following modules: stochastic event set, hazard, vulnerability, and exposure. The stochastic event set is an array of technology failure events with associated probabilities categorized by subsystem type and failure type. The subsystem types include sensing components (e.g., radar, lidar, GPS), communication components, software and control components, and map data. The failure types include manufacturing defects, design defects, bad input data, and malicious attacks. The hazard module maps each of these events to an affected footprint. For example, a GPS disruption due to a solar storm could impact the entire world for a short period of time, but mapping errors would be localized but would persist until they were corrected. The vulnerability module projects each event to outcomes in property damage, injury, recall expenses, etc. The exposure module predicts the geographical distribution of insured vehicles over time. The stochastic simulation of events with associated hazard footprints, vulnerability curves and exposure maps reveals the overall loss distribution but also lets us examine its sensitivity to technological advances.