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Illinois mandatory on-road driving test for older drivers

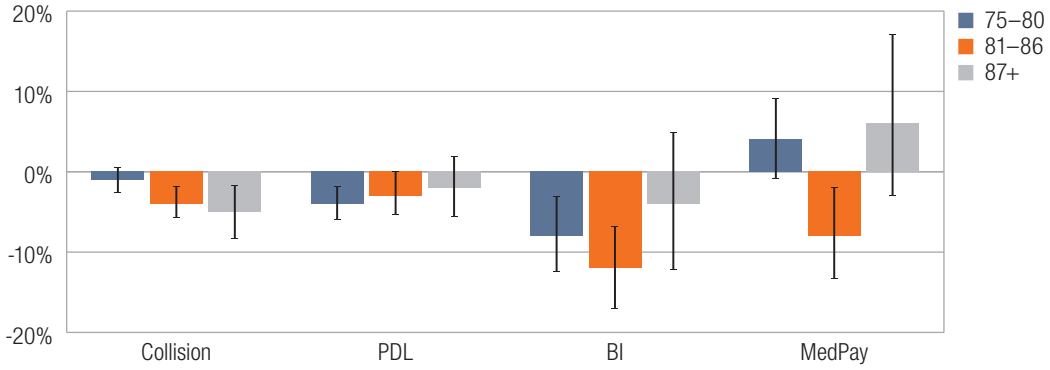
Summary

Illinois is the only state with a mandatory on-road driving test for older drivers. When drivers 75 and older renew their licenses in Illinois, they must take a driving test. The renewal period is every 4 years for drivers between ages 75–80, every 2 years for drivers 81–86 years old, and every year for those 87 and older. This study evaluated whether these procedures are affecting the insurance exposure and risk of older drivers in Illinois.

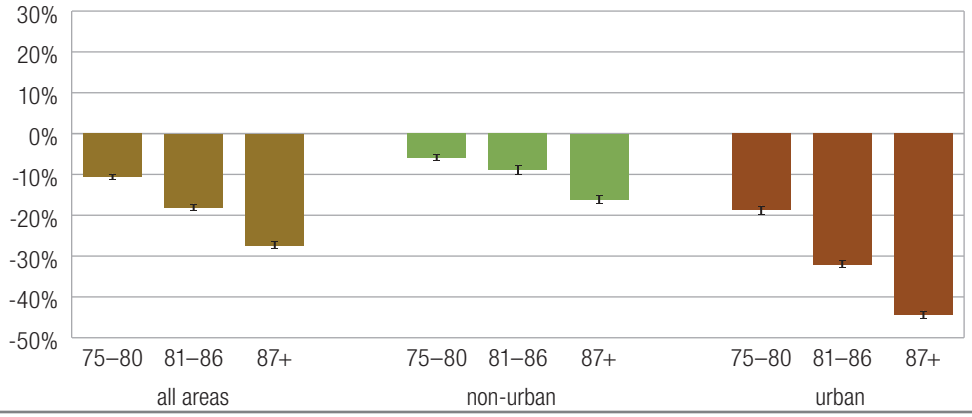
Exposure was measured in terms of the number of vehicles with bodily injury liability coverage whose rated drivers were in each of the older age groups (75–80, 81–86, and 87 and older) and compared as a ratio to the number of vehicles with rated drivers aged 55–74. Results show that the ratio of older drivers to younger drivers was lower than expected when compared with four neighboring states – Indiana, Iowa, Missouri, and Wisconsin and the difference is largest for the oldest age group (see figure below). Reductions in exposure were smaller in non-urban areas, perhaps because the lack of transportation alternatives motivates older drivers to take and pass the driving exam.

Results also show that the remaining older drivers were less risky. Again, taking into account the experience of younger drivers and neighboring states, claim frequencies under collision, property damage liability, and bodily injury liability were generally lower than expected for older drivers in Illinois (see figure below), although not all reductions were statistically significant. A fourth coverage, medical payments, showed mixed results.

Change in Illinois older driver claim frequency by rated driver age



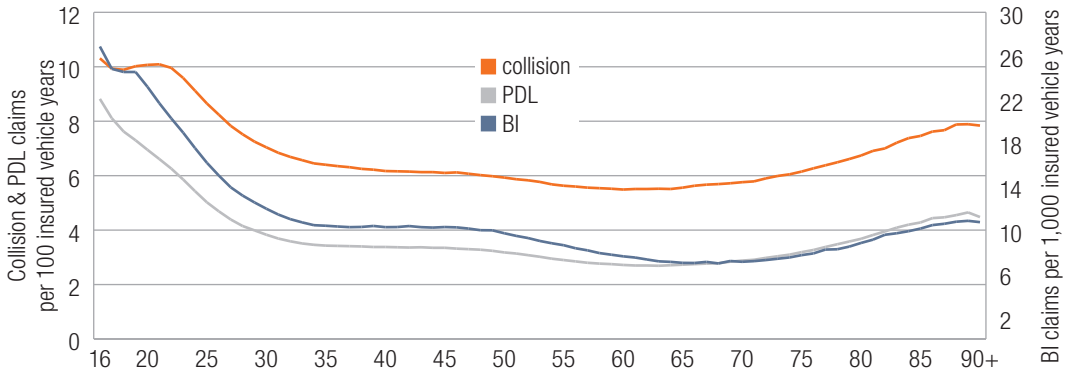
Estimated differences in the bodily injury liability exposure ratio of older drivers between Illinois and control states by vehicle density area



Introduction

The population of adults 65 and older is the fastest growing demographic in the United States. According to a U.S. Census Bureau (2014) report, by 2030 more than 20 percent of U.S. residents are projected to be 65 and older, compared with 13 percent in 2010 and 9.8 percent in 1970. As drivers age, they are at an elevated risk of involvement in motor vehicle crashes. Figure 1 depicts how collision, property damage liability and bodily injury liability claim frequency varies by driver age. Generally speaking, claim frequency decreases quickly from teenagers to young adults, and flattens out for prime age drivers until age 65 when claim frequencies begin to rise.

Figure 1: Claim frequency by rated driver age, 2011–14



To address the increase in crash risk for older drivers, many states apply stricter licensing procedures to older drivers. For example, some states require shorter renewal periods and/or mandatory in-person renewal and vision testing. Three states — Illinois, Indiana, and New Hampshire — have at some point mandated a road test for older drivers. In 2005, Indiana repealed its road test law followed by New Hampshire in 2011, leaving Illinois as the only state with a mandatory road test. Illinois currently requires a road test at every license renewal for drivers starting at age 75. The renewal period is every 4 years for drivers between ages 75–80, every 2 years for drivers 81–86 years old, and every year for those 87 and older.

The National Highway Traffic Safety Administration (NHTSA, 2013) examined driver licensing procedures for drivers 65 and older in all 50 states and found mixed results for the Illinois road test for older drivers. Although NHTSA reported crashes per population decreased in Illinois for older drivers subject to the road test, older drivers who remained driving showed an increase in crashes per licensed drivers. In 2014, another paper (Teft, 2014) on driver license renewal policies studied the influence of the on-road driving tests on population-based fatal crash involvement rates for Illinois, Indiana, and New Hampshire during 1986–2011. The analysis found "no significant evidence of any effect" of an on-road driving test for older drivers.

This current study examined the effect of Illinois's older driver road test by calculating and modeling claim frequencies and bodily injury liability exposure ratios. If the road test is effective, some amount of older drivers who are at an elevated crash risk should be removed from the driving population. Claim frequencies would be expected to decline as drivers with an elevated crash risk are removed from the driving population. Claim frequency measures the likelihood that an insurance loss will occur and is calculated as the number of claims per 100 (or 1,000) insured vehicle years (exposure). An insured vehicle year is equivalent to one vehicle insured for 1 year, two vehicles insured for 6 months, etc.

Additionally, if the on road driving test removes some drivers, then exposure should decline. To assess this, BI was used as it is required of all vehicles. Bodily injury liability exposure ratios should decline in Illinois at a faster rate than in the comparison states. The exposure ratio is the ratio of the exposure for one driver age group to another; it quantifies the exposure relationship between two different age groups. This study also examined how vehicle density (number of registered vehicles per square mile) would influence the effectiveness of Illinois' older driver road test. The study covers calendar years 2011–14 and is based on at least 10 million insured vehicle years for the four coverage types examined (collision, property damage liability, bodily injury liability, and medical payment).

Methods

Insurance data

Automobile insurance covers damage to vehicles and property, as well as injuries to people involved in crashes. Different insurance coverages pay for vehicle damage versus injuries, and different coverages may apply depending on who is at fault. The current study is based on collision, property damage liability, bodily injury liability, and medical payment coverages.

Collision coverage insures against vehicle damage to an at-fault driver's vehicle sustained in a crash with an object or other vehicle; this coverage is common to all 50 states. Property damage liability (PDL) coverage insures against vehicle damage that at-fault drivers cause to other people's vehicle and property in crashes; this coverage exists in all states except Michigan, where vehicle damage is covered on a no-fault basis (each insured vehicle pays for its own damage in a crash, regardless of who is at fault).

Coverage of injuries is more complex. Bodily injury (BI) liability coverage insures against medical, hospital, and other expenses for injuries that at-fault drivers inflict on occupants of other vehicles or others on the road. Although motorists in most states may have BI coverage, BI analysis in this study was limited to states with traditional tort insurance systems where the at-fault driver has first obligation to pay for injuries. Medical payment (MedPay) coverage covers injuries to insured drivers and the passengers in their vehicles, but not injuries to people in other vehicles involved in the crash. MedPay analysis in this study also was limited to states with traditional tort insurance systems.

States and older driver license procedures

Illinois, the study state with a traditional tort insurance system, is currently the only state with a mandatory road test that applies to drivers 75 and older at every license renewal. The four bordering tort states — Indiana, Iowa, Missouri, and Wisconsin — were used as control states. Older driver licensing procedures in these five states were examined including road test, license renewal cycle, in-person renewal, and proof of vision. **Table 1** lists the older driver licensing policies for Illinois and the control states. In all 5 states, older drivers are required to renew their licenses in person and provide proof of vision at every renewal. The length of the renewal cycle varied by state. In addition, the age at which a person is defined as an older driver varied. Details of the range in renewal cycle for younger drivers in Iowa can be found in **Appendix C**.

Table 2: Older driver licensing procedures, 2011–14

State	Road test	Renewal cycle	In person	Proof of vision
Illinois	Every renewal starting at age 75	4 years for age 55–80 2 years for age 81–86 1 year for age 87+	Every renewal	Every renewal
Indiana	None	6 years for age 55–74 3 years for age 75–84 2 years for age 85+	Every renewal	Every renewal
Iowa	None	5 years for age 55–69 in 2011–12 2 years for age 70+ in 2011–12 3–8 years or 74th birthday for age 55–71 in 2014 2 years for age 72+ in 2014	Every renewal	Every renewal
Missouri	None	6 years for age 55–69 3 years for age 70+	Every renewal	Every renewal
Wisconsin	None	8 years for all ages	Every renewal	Every renewal

Rated drivers

The rated driver is the one considered to represent the greatest loss potential for an insured vehicle under a policy. In a household with multiple vehicles and/or drivers, the assignment of drivers to vehicles can vary by insurance company and by state, but typically it reflects the driver most likely to operate the vehicle. Information on the actual driver at the time of a loss is not available in the Highway Loss Data Institute database. Because only the year of birth is available for most rated drivers, the exact age of the rated driver is unknown. A January 1 birthdate is assumed, resulting in a 2-year range in the actual age for a given rated driver. For example, the assigned age of 75 in this study can range from an actual age of 74 and 1 day to 75 and 364 days. The age groups used in the analysis include 75–80, 81–86, and 87 and older, while drivers aged 55–74 served as the comparison group.

Vehicles

The study vehicles were the 10 most recent model years for each calendar year during 2011–14. For example, data from calendar year 2011 included model years 2003–12, whereas data from calendar year 2014 included model years 2006–15. Iowa changed its older driver law in 2013, so loss data for Iowa in 2013 were excluded from the analysis. Total exposure and claims are shown in **Table 2**.

Table 2: Exposure and claims by coverage type

Coverage	Exposure (insured vehicle years)	Claims
Collision	11,395,036	641,047
Property damage liability	11,395,036	329,393
Bodily injury liability	11,614,660	75,739
Medical payment	10,677,067	86,133

Analysis methods

Claim frequency

Claim frequency was calculated for all vehicle density areas combined and then for non-urban (counties with 0–499 registered vehicles per square mile) and urban areas (counties with 500 or more registered vehicles per square mile). A Poisson regression logarithmic link function was used for each insurance coverage type to examine the differences in claim frequencies between each of the older driver age groups (75–80, 81–86, and 87 and older) and the comparison age group (55–74), while controlling for a variety of covariates in both Illinois and the comparison states. The difference in claim frequency between a study age group and its comparison age group in Illinois was then compared with the difference in the comparison states to test whether these two differences were statistically different.

The main independent variables in the analysis include:

State: A categorical variable to indicate whether the road test is applied during the study period.

Rated driver age: Rated driver ages were classified into three study age groups — 75–80, 81–86, and 87 and older — plus a comparison age group of 55–74. The control age group was selected because of enough loss data, the claim frequencies for each age group in Illinois were highly correlated to those in the control states, and the control age group spanned the typical retirement ages of 65–67, allowing for the adjustment of a possible lifestyle change after retirement.

Interaction of state and rated driver age: This categorical variable was designed to capture the different patterns in claim frequencies between the study age groups and the comparison age group with and without the road test provision. The 55–74 age group in the comparison states served as the baseline.

The regression model did not include renewal cycle because Illinois's road test is given every year for drivers 87 and older, and this 1-year renewal period was unique. Being an observational study, this analysis could not evaluate the "pure" effect of the road test independent of the renewal cycle.

Covariates included vehicle age, vehicle size and class, rated driver gender, rated driver marital status, deductible range (collision coverage only), risk, and calendar year. Vehicle density (number of registered vehicles per square mile) was used only in the model that applied to all vehicle density areas. The reference categories for the categorical independent variables were assigned to the values with the highest exposure: vehicle age = 6, vehicle size and class = midsize four-door car, gender = female, marital status = married, risk = standard, vehicle density = 1,000 or more vehicles per square mile, and calendar year = 2011.

For space reasons, illustrative full regression results for the effect of Illinois' older driver road test on collision claim frequency in all vehicle density areas are shown in **Appendix A**. To further simplify the presentation, the exponent of the parameter estimate was calculated, 1 was subtracted, and the result multiplied by 100. The resulting number corresponds to the effect of the feature on that loss measure. For example, the estimate of the effect of the road test on collision claim frequency for drivers 87 and older was -0.0545; thus, collision claim frequency for the road test is expected to be 5.3 percent lower than that for the other models ((exp(-0.0545) -1)*100 =-5.3).

Exposure ratio

Exposure ratios were calculated for bodily injury liability. Bodily injury liability coverage was selected since it is a required coverage for insured drivers. Collision coverage was not used for the ratios as it is an optional coverage not carried by all insured drivers. Bodily injury liability exposure data were stratified by vehicle age, vehicle size and class, gender, marital status, risk, vehicle density, calendar year, and state for each of the three study age groups (75–80, 81–86, and 87 and older) and the comparison age group (55–74). R75_80 was calculated as the ratio of the 75–80 age group exposure to that of the comparison age group. To avoid extreme ratios, only observations with at least 10 years of exposure for drivers aged 55–74 were included in the analysis. The calculation of R81_86 and R87 followed the same procedures.

Gamma regressions with a logarithmic link function were performed on each of the three BI exposure ratios, first in all vehicle density areas and then in non-urban and urban areas. The primary independent variable in modeling the exposure ratio was state, which had the same definition as in the claim frequency model.

The covariates and the reference groups used in the BI exposure ratio model were the same as in the claim frequency model. The detailed regression results of R75_80 are shown in **Appendix B**.

Results

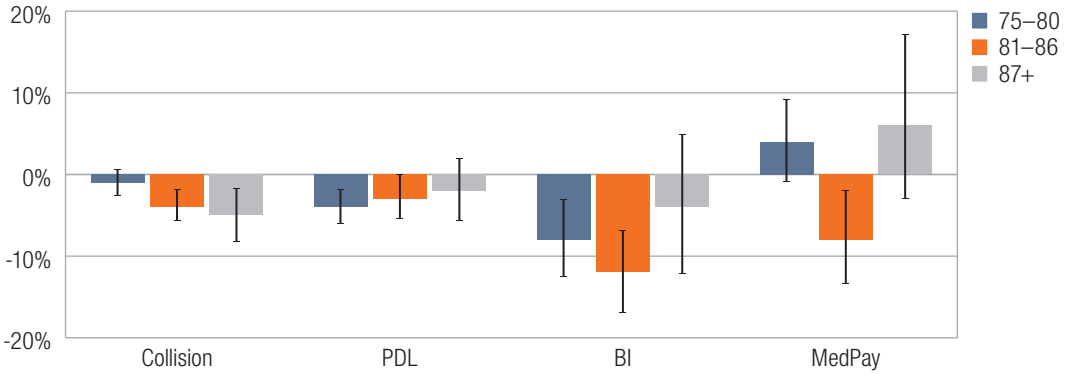
Figure 2 summarizes the estimated effects of Illinois' older driver road test on insurance claim frequencies by rated driver age group for the four coverage types.

The estimated reductions in collision claim frequency were 1, 4, and 5 percent, respectively, for drivers aged 75–80, 81–86, and 87 and older, exhibiting larger frequency reductions with age. The 1 percent estimated reduction for ages 75–80 was not significant, while the other two estimates were. The estimated PDL claim frequency reductions were 4, 3, and 2 percent, respectively, for the three driver age groups, with reductions for drivers aged 75–80 and 81–86 being significant.

The estimated BI claim frequency reductions were 8, 12, and 4 percent, respectively, for the three driver age groups, with reductions for drivers aged 75–80 and 81–86 being significant. The estimated effects for MedPay were a 4 percent increase in claim frequency for drivers aged 75–80, a significant 8 percent reduction for ages 81–86, and a 6 percent increase for drivers 87 and older.

Generally speaking, claim frequency reductions under the injury coverages were greater than first- and third-party vehicle damage coverages. It also should be noted that the claim frequency reductions for drivers aged 81–86 were significant across all insurance coverages.

Figure 2: Change in Illinois older driver claim frequency by rated driver age



Figures 3–6 illustrate the estimated effects of Illinois's older driver road test provision on insurance claim frequencies for rated drivers by age group and registered vehicle density for the four coverage types.

Figure 3 shows collision claim frequency estimates by driver age group and vehicle density area. In non-urban areas, the estimated collision effects were a 1 percent increase for drivers aged 75–80, a 1 percent reduction for ages 81–86, and a significant 6 percent decrease for drivers 87 and older. In urban areas, the collision effects were small, with a 0.4 percent increase for the youngest drivers (ages 75–80), a significant 6 percent decline for ages 81–86, and a 3 percent decline for drivers 87 and older. These results indicate that the claim frequency reductions for drivers aged 81–86 in all vehicle density areas is largely due to drivers in urban areas.

Figure 3: Estimated effects of Illinois' road test on collision claim frequencies by rated driver age

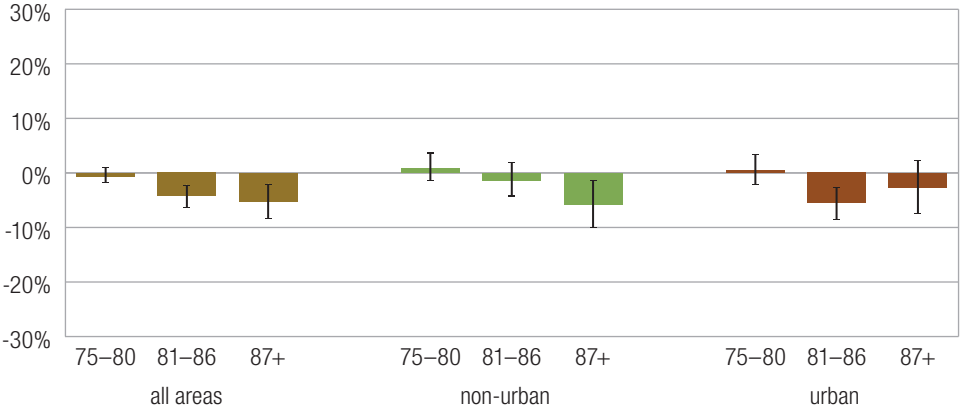


Figure 4 shows PDL claim frequency estimates by driver age group and vehicle density area. In non-urban areas, estimates for all three driver age groups were small, and none of them were significant. In urban areas, the 4 percent reduction for drivers aged 75–80 and the 6 percent reduction for drivers aged 81–86 were significant. The 1 percent decline for drivers 87 and older was not significant. Again, the estimated claim frequency reductions for the first two driver age groups in all vehicle density areas is largely due to drivers in urban areas.

Figure 4: Estimated effects of Illinois' road test on PDL claim frequencies by rated driver age and vehicle density area

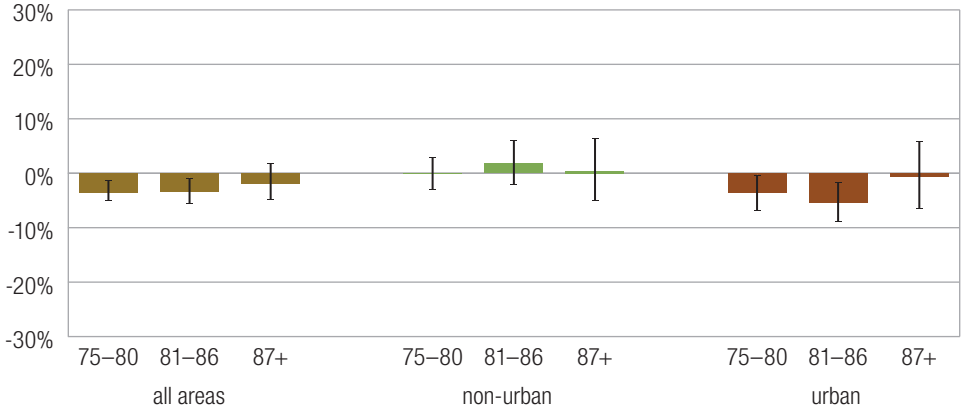


Figure 5 shows BI claim frequency estimates by driver age group and vehicle density area. The pattern of claim frequency estimates for BI is similar to that for PDL (Figure 4). In non-urban areas, estimated BI claim frequency reductions diminished with age, from a 4 percent decline for drivers aged 75–80 to a 0.1 percent increase for ages 81–86 and a 9.2 percent increase for the oldest drivers (87 and older). None of these effects were significant. In urban areas, estimated BI claim frequency reductions associated with the road test were observed for all driver age groups. Reductions for the youngest drivers (ages 75–80) were 6 percent lower than for the comparison age group (ages 55–74), followed by a significant 16 percent reduction for drivers aged 81–86. The effect dropped back down to 8 percent for the oldest drivers (87 and older). Again, the estimated claim frequency reductions for the first two driver age groups in all vehicle density areas were largely due to drivers in urban areas.

Figure 5: Estimated effects of Illinois' road test on BI claim frequencies by rated driver age and vehicle density area

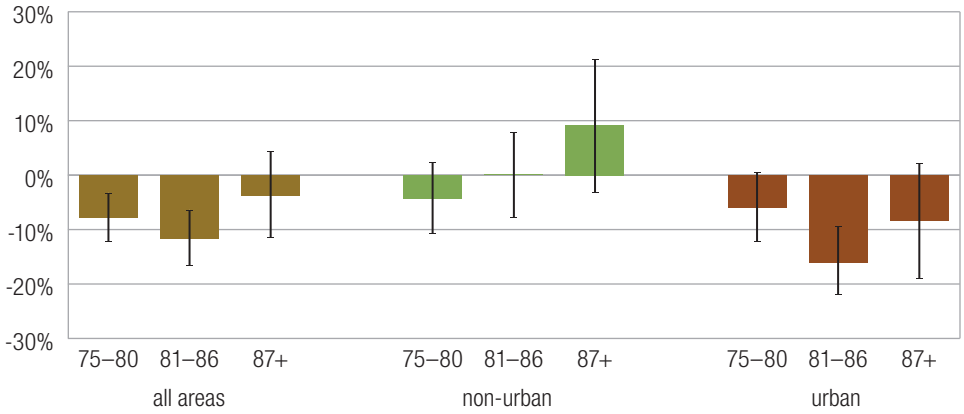


Figure 6 shows MedPay claim frequencies estimates by driver age group and vehicle density area. All three sets of estimates followed the same pattern: an increase for drivers aged 75–80, a reduction for ages 81–86, and an increase for drivers 87 and older. In non-urban areas, estimates were a 4 percent increase, a 4 percent decline, and a 7 percent increase, respectively, for the three driver age groups. In urban areas, estimates followed the same pattern with a 4 percent increase, a 7 percent decrease, and a 10 percent increase, respectively, for the three driver age groups. None of the six MedPay claim frequency estimates were significant.

Figure 6: Estimated effects of Illinois' road test on MedPay claim frequencies by rated driver age and vehicle density area

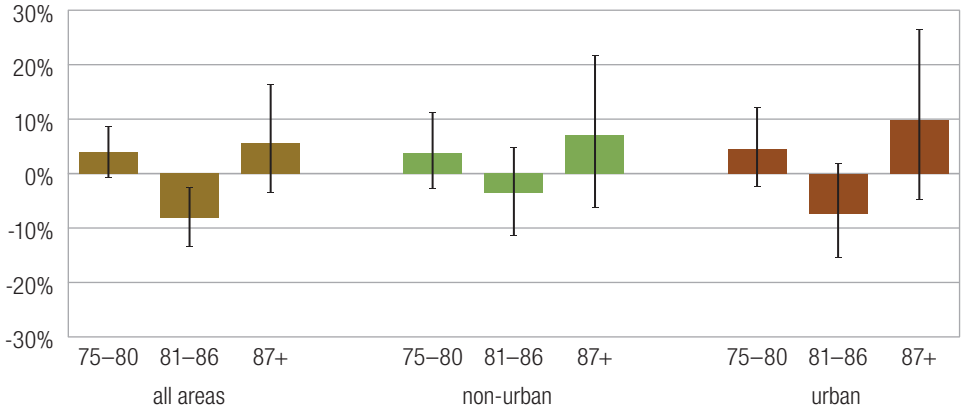
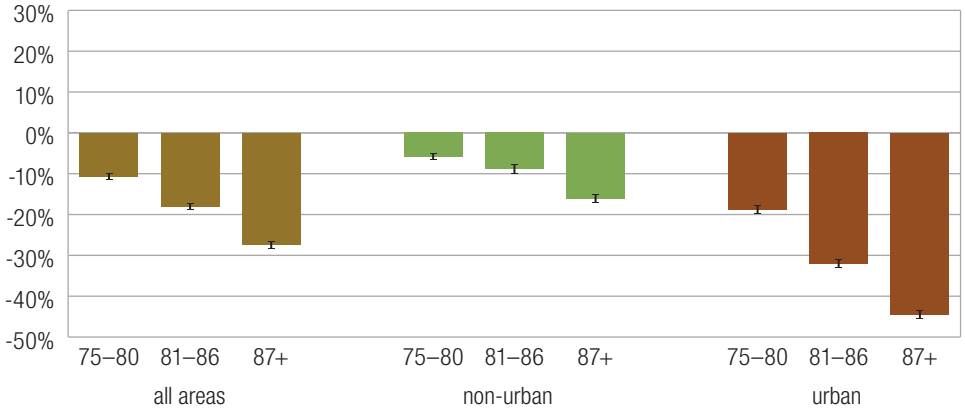


Figure 7 shows the estimated differences in the bodily injury liability exposure ratio between Illinois and the control states by driver age group and vehicle density area. The estimated differences in the bodily injury liability exposure ratio for Illinois's road test requirement for older drivers were significant for each driver age group in all vehicle density areas with declines in the ratio increasing with age from 11 to 27 percent. In non-urban areas, the reductions were 6, 9, and 16 percent, respectively, for the three driver age groups, with significant reductions for all age groups. In urban areas, the significant estimated reductions ranged from 19–44 percent across the three driver age groups. For each of the three driver age groups studied, the magnitude of the reduction increased with registered vehicle density. After eliminating the influences from covariates, a significantly lower BI exposure ratio in Illinois is evidence of the effectiveness of the road test in reducing the number of BI claims for older drivers.

Figure 7: Estimated differences in the bodily injury liability exposure ratio of older drivers between Illinois and control states by vehicle density area



The following table summarizes the study findings, with significant values indicated in bold.

Summarized effects of Illinois on-road driving test for older drivers, 2011–14									
	All areas			Non-urban			Urban		
Driver age	75–80	81–86	87+	75–80	81–86	87+	75–80	81–86	87+
Collision claim frequency	-1%	**-4%**	**-5%**	1%	-1%	**-6%**	0%	**-6%**	-3%
PDL claim frequency	**-4%**	**-3%**	-2%	0%	2%	0%	**-4%**	**-6%**	-1%
BI claim frequency	**-8%**	**-12%**	-4%	-4%	0%	9%	-6%	**-16%**	-8%
MedPay claim frequency	4%	**-8%**	6%	4%	-4%	7%	4%	-7%	10%
BI exposure ratio	**-11%**	**-18%**	**-27%**	**-6%**	**-9%**	**-16%**	**-19%**	**-32%**	**-44%**

Discussion

Illinois's on-road driving test for older drivers shows significant reductions in insurance claim frequencies. Bodily injury liability exposure for each of the driver age groups (75–80, 81–86, and 87 and older) decreased in Illinois relative to drivers age 55–74 by a significantly larger percentage than in the control states. While the effects on the bodily injury liability exposure ratio were uniformly larger in urban areas, only the effects on PDL and BI claim frequencies exhibited a similar pattern.

The decline in the bodily injury liability exposure ratio for older drivers could be a result of excluding older drivers with a higher crash risk from the driving population. Older drivers in a metropolitan area can rely more on public transportation for daily life than older drivers in non-urban areas, thus larger declines in bodily injury liability exposure were seen in urban areas as well as larger reductions in PDL and BI claim frequencies.

In general, Illinois older driver licensing procedures were found to be associated with claim frequency reductions, with the only exception being MedPay. Although not always statistically significant, Illinois procedures were also found to be associated with claim frequency reductions for all 3 age groups. MedPay claim frequency results are again the only exception showing no clear effect. The claim frequency reductions suggest that the drivers who were removed from the driving population were at a slightly higher risk of crashing than the remaining drivers. The decline in the BI exposure ratio shows that Illinois requirements are reducing the exposure of older drivers in Illinois at a faster rate than in the comparison states.

Limitations

As an observational study, an ideal model design was not possible. The 2-year renewal cycle for drivers aged 81–86 is uncommon, and the annual renewal period for drivers 87 and older is unique to Illinois. This made it impossible to estimate the "pure effect" of the road test independent of the renewal cycle based on the underlying data. Thus, the effects in this study should be viewed in a way that the road test is always acting in conjunction with the shortened renewal cycle.

References

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U.S. Census Bureau. 2014. Population Estimates and 2012 National Projections. Report no. P25-1140. Washington, DC: U.S. Department of Commerce.

Teft, B. C. 2014. Driver license renewal policies and fatal crash involvement rates of older drivers, United States, 1986–2011. *Injury Epidemiology* 1:25.

Appendix A: Illustrative regression results — collision frequency							
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald chi-square	P-value
Intercept		1	-8.7695		0.0063	1909359.00	<0.0001
Vehicle age	0	1	0.2488	28.2%	0.0058	1835.51	<0.0001
	1	1	0.2348	26.5%	0.0051	2097.64	<0.0001
	2	1	0.1854	20.4%	0.0052	1280.39	<0.0001
	3	1	0.1475	15.9%	0.0052	808.03	<0.0001
	4	1	0.1068	11.3%	0.0052	429.97	<0.0001
	5	1	0.0574	5.9%	0.0052	123.99	<0.0001
	7	1	-0.0618	-6.0%	0.0052	142.24	<0.0001
	8	1	-0.1367	-12.8%	0.0053	658.14	<0.0001
	-1	1	0.0543	5.6%	0.0174	9.70	0.0018
	6	0	0	0	0		
Size and class	Large 2dr cars	1	-0.2526	-22.3%	0.0440	33.00	<0.0001
	Large 4dr cars	1	-0.0604	-5.9%	0.0049	153.11	<0.0001
	Large cargo/passenger vans	1	-0.5808	-44.1%	0.0257	510.90	<0.0001
	Large luxury cars	1	0.0407	4.2%	0.0075	29.75	<0.0001
	Large luxury SUVs	1	-0.0798	-7.7%	0.0186	18.37	<0.0001
	Large minivans	1	-0.2255	-20.2%	0.0212	113.22	<0.0001
	Large pickups	1	-0.2831	-24.7%	0.0060	2207.69	<0.0001
	Large SUVs	1	-0.2030	-18.4%	0.0084	590.02	<0.0001
	Large sports cars	1	-0.2712	-23.8%	0.0277	95.61	<0.0001
	Large station wagons	1	-0.0164	-1.6%	0.0390	0.18	0.6750
	Micro 2dr cars	1	-0.6458	-47.6%	0.0670	92.81	<0.0001
	Micro 4dr cars	1	-0.1052	-10.0%	0.1857	0.32	0.5712
	Midsize 2dr cars	1	-0.0360	-3.5%	0.0117	9.50	0.0021
	Midsize cargo/passenger vans	1	-0.3486	-29.4%	0.1092	10.20	0.0014
	Midsize luxury cars	1	0.0472	4.8%	0.0075	39.83	<0.0001
	Midsize luxury SUVs	1	-0.0369	-3.6%	0.0077	22.74	<0.0001
	Midsize minivans	1	-0.6746	-49.1%	0.1387	23.65	<0.0001
	Midsize SUVs	1	-0.2195	-19.7%	0.0049	2030.79	<0.0001
	Midsize sports cars	1	-0.5113	-40.0%	0.0161	1007.98	<0.0001
	Midsize station wagons	1	-0.1498	-13.9%	0.0138	117.46	<0.0001
	Mini 2dr cars	1	-0.3051	-26.3%	0.0216	198.70	<0.0001
	Mini 4dr cars	1	-0.0369	-3.6%	0.0139	7.07	0.0078
	Mini SUVs	1	0.0877	9.2%	0.4083	0.05	0.8300
	Mini sports cars	1	-0.6520	-47.9%	0.0560	135.62	<0.0001
	Mini station wagons	1	-0.1121	-10.6%	0.0150	56.08	<0.0001
	Small 2dr cars	1	-0.0514	-5.0%	0.0110	21.64	<0.0001
	Small 4dr cars	1	-0.0225	-2.2%	0.0048	21.54	<0.0001
	Small luxury cars	1	0.1797	19.7%	1.0000	0.03	0.8574
	Small luxury SUVs	1	-0.2448	-21.7%	0.0511	22.97	<0.0001
	Small pickups	1	-0.4403	-35.6%	0.0104	1804.49	<0.0001
	Small SUVs	1	-0.2425	-21.5%	0.0052	2146.86	<0.0001
	Small sports cars	1	-0.6156	-46.0%	0.0300	421.31	<0.0001
	Small station wagons	1	-0.1058	-10.0%	0.0073	210.83	<0.0001
	Very large 4dr cars	1	-0.1814	-16.6%	0.0159	130.01	<0.0001

Appendix A: Illustrative regression results — collision frequency							
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald chi-square	P-value
	Very large luxury cars	1	0.0229	2.3%	0.0135	2.89	0.0889
	Very large luxury SUVs	1	-0.0873	-8.4%	0.0370	5.57	0.0183
	Very large Minivans	1	-0.0635	-6.2%	0.0060	113.19	<0.0001
	Very large pickups	1	-0.2136	-19.2%	0.0108	391.37	<0.0001
	Very large SUVs	1	-0.2138	-19.2%	0.0163	171.97	<0.0001
	Midsize 4dr cars	0	0	0	0		
Rated driver gender	Male	1	-0.0142	-1.4%	0.0035	16.51	<0.0001
	Unknown	1	-0.0533	-5.2%	0.0050	113.17	<0.0001
	Female	0	0	0	0		
Rated driver marital status	Single	1	0.207	23.0%	0.0041	2502.57	<0.0001
	Unknown	1	0.1195	12.7%	0.0050	580.50	<0.0001
	Married	0	0	0	0		
Risk	Nonstandard	1	0.3059	35.8%	0.0075	1672.38	<0.0001
	Standard	0	0	0	0		
Deductible range	0–100	1	0.3461	41.4%	0.0038	8293.99	<0.0001
	101–250	1	0.2346	26.4%	0.0030	6239.60	<0.0001
	>500	1	-0.4158	-34.0%	0.0055	5718.23	<0.0001
	251–500	0	0	0	0		
Registered vehicle density	0–49	1	-0.3654	-30.6%	0.0047	5959.46	<0.0001
	50–99	1	-0.3247	-27.7%	0.0046	4887.71	<0.0001
	100–249	1	-0.2379	-21.2%	0.0041	3434.36	<0.0001
	250–499	1	-0.2247	-20.1%	0.0039	3291.41	<0.0001
	500–999	1	-0.1931	-17.6%	0.0043	2020.40	<0.0001
	1,000+	0	0	0	0		
Calendar year	2012	1	-0.0151	-1.5%	0.0036	18.13	<0.0001
	2013	1	0.0147	1.5%	0.0036	16.50	<0.0001
	2014	1	0.0707	7.3%	0.0035	410.75	<0.0001
	2011	0	0	0	0		
Rated driver age	75–80	1	0.1185	12.6%	0.0057	436.62	<0.0001
	81–86	1	0.2297	25.8%	0.0071	1052.82	<0.0001
	87+	1	0.3032	35.4%	0.0109	777.11	<0.0001
	55–74	0	0	0	0		
State	Illinois	1	0.0233	2.4%	0.0030	60.30	<0.0001
	control	0	0	0	0		
Rated driver age * state	75–80*Illinois	1	-0.0064	-0.6%	0.0084	0.59	0.4420
	75–80*control	0	0	0	0		
	81–86*Illinois	1	-0.0432	-4.2%	0.0106	16.74	<0.0001
	81–86*control	0	0	0	0		
	87+*Illinois	1	-0.0545	-5.3%	0.0164	11.04	0.0009
	87+*control	0	0	0	0		
	55–74*Illinois	0	0	0	0		
	55–74*control	0	0	0	0		

Appendix B: Illustrative exposure ratio results — bodily injury liability							
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald chi-square	P-value
Intercept		1	-2.4793		0.0107	54118.20	<0.0001
Vehicle age	0	1	-0.0182	-1.8%	0.0086	4.47	0.0345
	1	1	-0.0012	-0.1%	0.0081	0.02	0.8800
	2	1	0.0146	1.5%	0.0080	3.30	0.0691
	3	1	0.0131	1.3%	0.0079	2.75	0.0972
	4	1	0.0268	2.7%	0.0078	11.92	0.0006
	5	1	0.0047	0.5%	0.0076	0.38	0.5389
	7	1	0.0063	0.6%	0.0074	0.72	0.3971
	8	1	0.0148	1.5%	0.0074	3.99	0.0458
	-1	1	0.0501	5.1%	0.0172	8.48	0.0036
	6	0	0	0	0		
Size and class	Large 2dr cars	1	-0.5689	-43.4%	0.0622	83.56	<0.0001
	Large 4dr cars	1	0.5391	71.4%	0.0096	3123.66	<0.0001
	Large cargo/passenger vans	1	-0.1741	-16.0%	0.0210	68.61	<0.0001
	Large luxury cars	1	0.3785	46.0%	0.0115	1079.53	<0.0001
	Large luxury SUVs	1	-0.3794	-31.6%	0.0219	299.85	<0.0001
	Large minivans	1	0.4533	57.3%	0.0195	540.91	<0.0001
	Large pickups	1	-0.4742	-37.8%	0.0102	2162.69	<0.0001
	Large SUVs	1	-0.3257	-27.8%	0.0115	802.86	<0.0001
	Large sports cars	1	-0.5631	-43.1%	0.0295	364.04	<0.0001
	Large station wagons	1	0.0838	8.7%	0.0430	3.79	0.0515
	Micro 2dr cars	1	-0.1784	-16.3%	0.0686	6.75	0.0093
	Micro 4dr cars	1	-1.3749	-74.7%	0.3977	11.95	0.0005
	Midsize 2dr cars	1	-0.3750	-31.3%	0.0139	727.11	<0.0001
	Midsize cargo/passenger Vans	1	-0.1609	-14.9%	0.1698	0.90	0.3433
	Midsize luxury cars	1	-0.1066	-10.1%	0.0118	82.12	<0.0001
	Midsize luxury SUVs	1	-0.1812	-16.6%	0.0117	241.48	<0.0001
	Midsize minivans	1	-0.2253	-20.2%	0.2516	0.80	0.3706
	Midsize SUVs	1	-0.3431	-29.0%	0.0095	1296.94	<0.0001
	Midsize sports cars	1	-0.7214	-51.4%	0.0150	2305.74	<0.0001
	Midsize station wagons	1	-0.0799	-7.7%	0.0145	30.35	<0.0001
	Mini 2dr cars	1	-0.3729	-31.1%	0.0231	260.52	<0.0001
	Mini 4dr cars	1	0.0290	2.9%	0.0154	3.53	0.0603
	Mini sports cars	1	-0.2638	-23.2%	0.0598	19.46	<0.0001
	Mini station wagons	1	-0.1262	-11.9%	0.0159	63.22	<0.0001
	Small 2dr cars	1	-0.4405	-35.6%	0.0129	1172.46	<0.0001
	Small 4dr cars	1	-0.1226	-11.5%	0.0095	166.42	<0.0001
	Small luxury SUVs	1	0.2653	30.4%	0.0484	30.03	<0.0001
	Small pickups	1	-0.1628	-15.0%	0.0115	199.86	<0.0001
	Small SUVs	1	-0.3617	-30.4%	0.0097	1399.02	<0.0001
	Small sports cars	1	-0.4791	-38.1%	0.0248	372.20	<0.0001
	Small station wagons	1	-0.1637	-15.1%	0.0103	250.63	<0.0001
	Very large 4dr cars	1	1.3778	296.6%	0.0188	5389.57	<0.0001
	Very large luxury cars	1	0.8555	135.3%	0.0165	2678.68	<0.0001
	Very large luxury SUVs	1	0.1204	12.8%	0.0533	5.11	0.0237

Appendix B: Illustrative exposure ratio results — bodily injury liability							
Parameter		Degrees of freedom	Estimate	Effect	Standard error	Wald chi-square	P-value
	Very large Minivans	1	0.3921	48.0%	0.0104	1423.39	<0.0001
	Very large pickups	1	-0.5775	-43.9%	0.0129	2009.67	<0.0001
	Very large SUVs	1	-0.3690	-30.9%	0.0154	572.07	<0.0001
	Midsize 4dr cars	0	0	0	0		
Rated driver gender	Male	1	0.1080	11.4%	0.0045	575.14	<0.0001
	Unknown	1	-0.1006	-9.6%	0.0067	227.12	<0.0001
	Female	0	0	0	0		
Rated driver marital status	Single	1	0.3479	41.6%	0.0053	4247.68	<0.0001
	Unknown	1	0.3204	37.8%	0.0060	2887.62	<0.0001
	Married	0	0	0	0		
Risk	Nonstandard	1	-0.3955	0.0%	0.0114	1207.26	<0.0001
	Standard	0	0	0	0		
Registered vehicle density	0–49	1	0.3135	36.8%	0.0067	2185.86	<0.0001
	50–99	1	0.2381	26.9%	0.0066	1298.02	<0.0001
	100–249	1	0.1508	16.3%	0.0063	576.16	<0.0001
	250–499	1	0.0733	7.6%	0.0062	141.23	<0.0001
	500–999	1	0.0189	1.9%	0.0065	8.62	0.0033
	1,000+	0	0	0	0		
Calendar year	2012	1	0.0233	2.4%	0.0052	20.07	<0.0001
	2013	1	0.0332	3.4%	0.0054	37.85	<0.0001
	2014	1	0.0662	6.8%	0.0053	158.90	<0.0001
	2011	0	0	0	0		
State	Illinois	1	-0.1133	-10.7%	0.0042	731.72	<0.0001
	control	0	0	0	0		

Appendix C: Iowa license renewal cycles in 2014 by driver age	
Age	Renewal cycle
55–66	5–8 years (selected randomly)
67	5–7 years (selected randomly)
68	5–6 years (selected randomly)
69	5 years
70	4 years
71	3 years
72+	2 years

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