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Watch for motorcycles! The effects of texting and handheld bans on motorcyclist fatalities

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ABSTRACT

Motorcyclists account for a much higher proportion of traffic fatalities relative to the share of motorcycles among all motor vehicles and vehicle miles driven in the U.S. In this paper, we posit that motorcyclists may be particularly vulnerable to the risks of distracted driving by others. Specifically, we examine whether state-specific texting/handheld bans significantly influence motorcyclist fatalities in the U.S. We use state-specific traffic fatality data in the U.S. (2005–2015, $N = 550$) from the Fatality Analysis Reporting System (FARS) merged with state-specific characteristics, texting/handheld device laws, and other traffic policies. Although research is mixed on the effectiveness of texting/handheld bans for overall traffic fatalities, our findings indicate that motorcyclists are at elevated risk of being a victim of distracted driving and thus could greatly benefit from these policies. This result is driven mainly by multiple-vehicle crashes (e.g., car hitting motorcycle) as opposed to single-vehicle crashes. Policy makers should consider strengthening texting/handheld bans along with their enforcement to improve safety and save lives, especially among motorcyclists.

1. Introduction

Distracted driving is now recognized as one of the most serious safety concerns for motor vehicle occupants, bicyclists, and pedestrians (e.g., Ferdinand and Menachemi, 2014). The National Highway Traffic Safety Administration (NHTSA, 2017a) reports that in the U.S., about nine people are killed and more than 1000 injured daily in traffic crashes that involve distracted drivers. Drivers engage in many different forms of distracting behaviors (e.g., eating, drinking, tuning a radio), but the most alarming form is using mobile devices while operating a vehicle (Wilson and Stimpson, 2010). For example, more than two-thirds of drivers ages 18–64 in the U.S. report talking on a cellphone while driving and almost a third of them report texting while driving (Centers for Disease Prevention and Control [CDC], 2013).

Driving while using a mobile phone (handheld or hands-free) has been shown to restrict driver's movements, distract their attention from the road, and impair their reaction time (e.g. McCartt et al., 2006; Caird et al., 2008; Simmons et al., 2016). A recent meta-analysis concludes that typing and reading text messages while driving compromises traffic safety (Caird et al., 2014). It is estimated that across the U.S. in 2015, 476 people died and an additional 30,000 were injured in motor vehicle crashes involving drivers distracted by cellphone use alone (NHTSA, 2017a). As the prevalence of using a mobile phone while driving has increased and public concern has mounted (94% of drivers support a ban on texting while driving and 74% are in favor of a ban on handheld cellphone use [Schroeder et al., 2013]), individual states have passed laws to discourage some or all of these practices. The first state to pass such a law was New York in 2001, where drivers were banned from talking on a handheld cellphone while operating a motor vehicle (Cheng, 2015). As of September 2018, 16 states plus Washington, D.C. prohibit all drivers from talking on a handheld cellphone while driving and 38 states plus Washington, D.C. ban any cellphone use by novice drivers. The legislative process has been more active for texting, with 47 states plus Washington, D.C. establishing a ban on text messaging for all drivers. Currently, the only state without a texting ban of any form is Montana.

Research on the effectiveness of texting/handheld device policies has flourished in recent years. McCartt et al. (2014) provide a systematic review of the studies examining the effectiveness of texting/handheld bans in the U.S. The findings are largely mixed, however,

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with some studies showing a limited or short-lived positive impact of these policies on traffic fatalities (e.g. Abouk and Adams, 2013; Ferdinand et al., 2014; Rocco and Sampaio, 2016) and others showing small or non-significant effects (e.g., Bhargava and Pathania, 2013; Lim and Chi, 2013). Crash-related hospitalizations seem more responsive to such policies than traffic fatalities (Ferdinand et al., 2015), which could simply be an artifact of a relatively larger number of hospitalizations in comparison to the number of fatalities. Although some researchers find that texting/handheld bans significantly reduce drivers' cellphone use (e.g., Cheng, 2015; Zhu et al., 2016), these bans do not seem to translate into meaningful reductions in traffic crashes and fatalities.

One potential explanation is that drivers engage in compensatory behavior when they are using their cellphones, such as reducing their speed and/or keeping more space between them and other vehicles (Choudhary and Velaga, 2017). Another explanation is that the crashes caused by drivers distracted by their cellphone use may be leading mostly to non-fatal injuries rather than fatal ones, hence the lack of significant estimated effects of texting/handheld bans on mortality risk. Moreover, differences may be present in the effects of such bans on new versus experienced drivers. Texting/handheld policies could have a more pronounced effect on new drivers relative to more experienced drivers given that the latter group may have more established driving habits. New drivers, however, are typically younger individuals who may be more active mobile device users—especially texting—and also less likely to process the risks of distracted driving (Cazzulino et al., 2014). Ferdinand et al. (2014) report that texting laws for either group of drivers do not significantly reduce traffic fatalities unless coupled with primary enforcement. Primary enforcement allows police officers to issue a ticket to a driver without any other traffic offence taking place. Secondary enforcement, a much weaker criterion, allows law enforcement officers to issue a ticket to a driver only when another citable traffic violation is observed (e.g., speeding, illegal turn).

Considering motor vehicle crashes in the aggregate, however, may obscure how these policies impact motorcyclists—a group of motor vehicle operators that is particularly vulnerable to the risks of distracted driving by others. According to a recent NHTSA (2017b) report, motorcyclists account for 14% of all traffic fatalities in the U.S. even though they make up only about 3% of all motor vehicles and 0.6% of all vehicle miles traveled. Adjusting for vehicle miles traveled, motorcyclist fatalities are almost 29 times more frequent than passenger car occupant fatalities (NHTSA, 2017b). According to our own calculations using Fatality Analysis Reporting System (FARS) data, the share of motorcyclist deaths among all motor vehicle fatalities has gone up by more than 30% in just 11 years from 2005 to 2015. Finally, at least part of the explanation could be that motorcyclists are harder to see and avoid, even for experienced and attentive motor vehicle operators. Motorcyclists are particularly vulnerable to crashes caused by distracted divers because motorcycles suffer from the so-called "low conspicuity" problem given their smaller size compared to other motor vehicles, and they can easily get obscured by narrow sight lines and blind spots in modern cars and trucks (Hurt et al., 1981). Without many of the safety features present in late-model automobiles and light trucks (e.g., air bags, seat belts, anti-lock brakes, steel shell), motorcycles provide little protection for their occupants in the case of a crash.

To the best of our knowledge, the present research is the first study to quantify the impact of texting/handheld laws on motorcyclist fatalities. Using 11 years of FARS data, we estimate the effects of texting/handheld bans on both motorcyclist and non-motorcyclist fatalities. In addition, we disaggregate the analyses into fatalities involving both single- and multiple-vehicle crashes. We also contribute to the literature by categorizing various texting/handheld policies into a four-level rating system—*strong*, *moderate*, *weak*, and no bans.

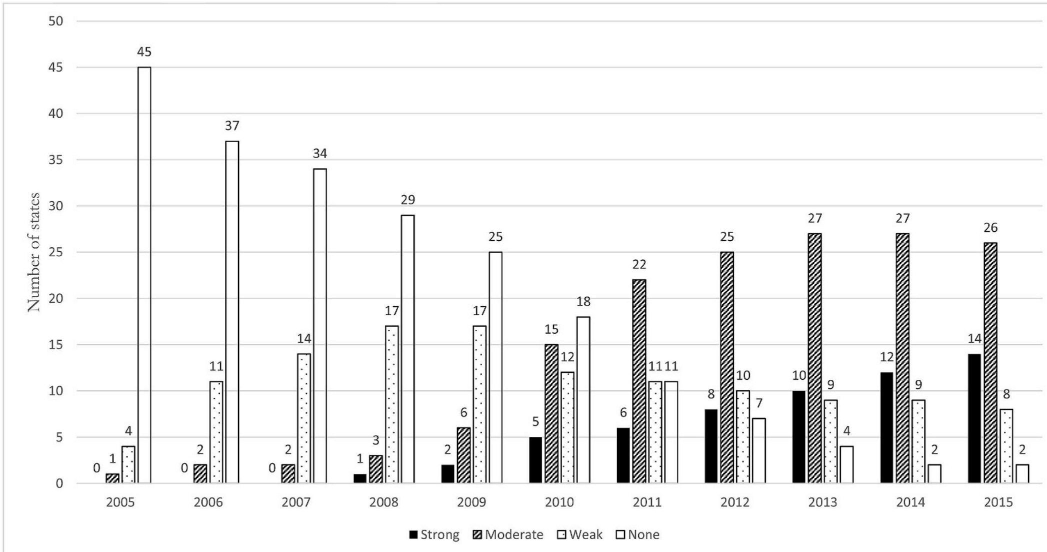
2. Data and methods

The motor vehicle fatality data used in this study come from FARS, a publicly available data source maintained by NHTSA. FARS is a census of all motor vehicle traffic crashes that occur on public roads in the U.S. and result in a fatality within 30 days. We obtained annual data on total and motorcycle-specific traffic fatalities for the period of 2005–2015 for all 50 states (Washington, D.C. is excluded). Given that we use publicly-available files of secondary data aggregated at the state level, it was not necessary to obtain institutional review board approval for research involving human subjects. Crash characteristics, including the number and type of vehicle(s), come from police reports. Motorcyclist fatalities refer to both motorcycle operators and passengers, excluding occupants of scooters, mopeds, and off-road vehicles. Traffic fatalities in crashes involving no motorcycles refer to other motor vehicle occupants (i.e., drivers and passengers) as well as non-occupants (e.g., pedestrians, bicyclists) killed in traffic crashes. Appendix Table A1 provides detailed definitions and a list of data sources for all variables used in the analyses.

It is highly unlikely for motorcycle operators to use mobile devices while riding because motorcycle riding requires manual shifting, additional motor and perceptual skills, as well as balance and coordination (Motorcycle Safety Foundation, 2009). In fact, several studies report very low prevalence of talking or texting on cellphones while riding among bicyclists and motorcyclists. In a recent study, researchers observed only 0.64% of 4244 motorcyclists in Mexico using their mobile phones while riding (Pérez-Núñez et al., 2014). In another study of 7102 bicyclists in the Netherlands, only 3% of them were observed making calls, texting, or typing on their cellphones (de Waard et al., 2015). The insights from these studies, however, are somewhat limited given the vast differences between the U.S. and these countries. For example, self-reported cellphone use while driving is lower both in the Netherlands (less than 50%) and in Mexico (about 11%) than in the US (CDC, 2013; Vera-López et al., 2013). On the other hand, the share of motorcycle, bicycle, and scooter rider deaths make up more than half of all traffic fatalities in the Netherlands—a reflection of both shorter distances traveled and a greater popularity of these vehicles in comparison to the US (Bicycle Dutch, 2018). Mexico is less developed than the US, which leads to many differences in both driving and commuting patterns as well as traffic fatalities between these countries. In particular, the shares of pedestrian and urban traffic fatalities are much higher in Mexico (Híjar et al., 2003; Inclán et al., 2005) compared to the US (NHTSA, 2018a, 2018b).

More recently, Wolfe et al. (2016) observed the practices of bikers in Boston, MA—a metropolitan city in Northeastern U.S. They reported only 29 out of 1974 bikers (i.e. less than 1.5%) holding a cellphone in their hand or positioned on handlebars (but not necessarily using these devices). Hence, we conjecture that texting/handheld device policies are much more likely to protect motorcycles from being hit by distracted drivers of other vehicles than to prevent motorcyclists from causing crashes. In our empirical analysis, we conduct sub-analyses separately for motorcyclist fatalities in single-versus multiple-vehicle crashes. As a benchmark for the motorcycle findings and the literature at large, we also estimate the effectiveness of these laws for all other fatalities in single- and multiple-vehicle crashes involving no motorcycles.

Information on state-level texting/handheld policies was collected from several sources including Anderson et al. (2013), Cheng (2015), and McCartt et al. (2014). Effective dates were confirmed using various local news articles and state websites as listed in Appendix Table A1. Handheld device bans prohibit drivers from talking on cellphones while operating motor vehicles. Texting bans prevent drivers from text messaging on their cellphones. While some early handheld bans (e.g., Connecticut and the District of Columbia) were worded such that they covered text messaging as well, most states generally adopted specific texting bans separately from the handheld bans starting with Washington state in 2008. Most states that have both bans typically implemented them simultaneously. Texting/handheld bans can assume several forms, including primary versus secondary enforcement for all



Notes: See the text for rating definitions.

Fig. 1. State Texting and Handheld Ban Ratings, 2005-2015.
Notes: See the text for rating definitions.

drivers and those that apply only to novice drivers. To standardize and operationalize the strictness of these bans, we assigned states to one of four mutually exclusive and collectively exhaustive ban categories: *strong*, *moderate*, *weak*, and *none*. Ibrahim et al. (2011) demonstrate that many other subtleties to these laws exist in terms of various communication devices and activities, categories of drivers (e.g., school bus drivers), and punishments, which our rating system does not capture.

In each year, a state is classified as having a *strong* ban if primary enforcement of both handheld device and texting bans are in place for all drivers. As explained by Abouk and Adams (2013), having both texting and handheld bans should have a stronger impact on drivers' behavior. Otherwise, not having handheld laws banning drivers from dialing or talking on a phone while driving would make the enforcement of texting bans more difficult. A *moderate* ban designation occurs when a state has primary enforcement (all drivers) of either a handheld device ban or texting ban (but not both). Having either a secondary enforcement texting/handheld ban or any ban applied only to novice drivers earns the distinction of a *weak* ban. The final category is no ban of any type during a particular year.

Fig. 1 presents trends in texting/handheld ban ratings from 2005 to 2015. This graph indicates that the policies have gradually ramped up in recent years. In 2005, no states had a *strong* texting/handheld ban rating, one had *moderate*, four had *weak*, and 45 had *none*. These statistics look quite different by 2015, with 14 states having a *strong* ban rating, 26 having *moderate*, eight with *weak*, and only two states with *none*. As seen in Fig. 1, states often started by adopting bans for novice drivers only, which over time were strengthened. Thus, substantial within- and across-state changes in the presence and type of bans from 2005 to 2015 provide sufficient policy variation for the statistical analyses that follow. Our empirical models also incorporate a broad set of other policy measures and controls to account for potentially confounding determinants of traffic safety.

Table 1 provides descriptive statistics for the entire sample, which includes 550 observations (50 states over 11 years). The average annual number of motorcyclist fatalities in a given state is about 91, of which 41 have occurred in single-vehicle crashes and 50 in multiple-vehicle crashes. Not surprisingly, traffic fatalities in crashes involving no motorcycles are much more common, with an average annual number of 632, of which 376 have occurred in single-vehicle crashes and 256 in multiple-vehicle crashes. Presented in a different way, 55.0% of motorcyclist fatalities involve multiple vehicles versus only 40.5% for all other vehicle fatalities. This stark contrast clearly demonstrates that motorcyclists are at heightened risk for multiple-vehicle crashes, including those caused by other distracted drivers.

In our sample, 12.4% (2.6%) of the state-year observations had a primary (secondary) handheld ban in place and 36.2% (5.1%) had a primary (secondary) texting ban. In addition, some states had bans for novice drivers only. Specifically, 30.4% (7.1%) of the state-year observations had a primary (secondary) handheld ban and 9.8% (3.1%) of the sample had a primary (secondary) texting ban for novice drivers only. Using the criteria specified earlier, this translates into 10.5% of state-year observations with a *strong* texting/handheld ban rating, 28.4% with a *moderate* rating, 22.2% with a *weak* rating, and 38.9% with no bans of any type. Based on evidence provided by the extant literature regarding their potential influence on traffic safety, we include four other traffic policies as control variables—presence of a graduated driver-licensing law (e.g., Ferdinand et al., 2014, 2015); speed limits (e.g., Cohen and Einav, 2003; Ferdinand et al., 2014); universal helmet law (e.g., French et al., 2009), and primary and secondary enforcement of seat belt laws (e.g., Cohen and Einav, 2003; Ferdinand et al., 2014). All policy measures are defined at the bottom of Table 1 and all indicator variables (except speed limits) take on fractional values for the years in which laws changed. We are unable to account for several other important alcohol-related policies, such as blood alcohol concentration limits and zero tolerance laws, due to lack of within-state variation in these measures during the 2005–2015 period.

We follow the existing literature (e.g., Abouk and Adams, 2013; Ferdinand et al., 2014, 2015; French et al., 2009) and include several other control variables in all specifications: total vehicle miles traveled (VMT) per licensed driver, average annual precipitation (inches), and average annual temperature (degrees F). We also control for the unemployment rate and real personal income per capita (in constant 2015 US dollars) because it has been shown that business cycles and the level of economic activity can greatly affect motor vehicle fatalities in general (Ruhm, 2000) and motorcyclist fatalities in particular (French and Gumus, 2014).

The empirical specification for the core estimation results takes the following basic form:

$$F_{st} = \beta_0 + \boldsymbol{P}_{st}\beta_1 + \boldsymbol{X}_{st}\beta_2 + \lambda_t + \delta_s + \varepsilon_{st} \quad (1)$$

where F_{st} is the natural logarithm of fatalities per 100,000 people in

Table 1
Descriptive statistics, 2005–2015 (N = 550).

	Mean	Std. Dev.	Min	Max
Outcome measures				
Fatality rates per 100,000 people				
Motorcyclist fatalities in all crashes	1.585	0.613	0.271	5.5
Single vehicle crashes	0.770	0.381	0.000	3.9
Multiple vehicle crashes	0.816	0.329	0.095	2.3
Traffic fatalities in crashes that involved no motorcycles	11.695	5.048	3.503	34.2
Single vehicle crashes	7.057	3.210	2.272	21.4
Multiple vehicle crashes	4.638	2.043	0.758	12.8
Fatality counts				
Motorcyclist fatalities in all crashes	90.8	103.6	2	569
Single vehicle crashes	40.7	41.3	0	228
Multiple vehicle crashes	50.1	63.5	1	391
Traffic fatalities in crashes that involved no motorcycles	632.0	638.3	37	3868
Single vehicle crashes	376.3	377.5	23	2303
Multiple vehicle crashes	255.7	264.9	8	1565
Policy measures				
Primary handheld ban[a]	0.124	0.324	0	1
Primary handheld ban - novice drivers only[b]	0.304	0.450	0	1
Primary texting ban[c]	0.362	0.468	0	1
Primary texting ban - novice drivers only[b]	0.098	0.287	0	1
Texting/handheld ban rating[d]				
Strong	0.105	0.307	0	1
Moderate	0.284	0.451	0	1
Weak	0.222	0.416	0	1
None	0.389	0.488	0	1
Speed limit ≥ 75mph	0.271	0.445	0	1
Graduated driver-licensing law[e]	0.944	0.223	0	1
Universal helmet law[f]	0.393	0.489	0	1
Seat belt law - Primary enforcement[g]	0.574	0.489	0	1
Seat belt law - Secondary enforcement[g]	0.403	0.485	0	1
Control variables				
Population (1,000)	6166	6813	514	39,100
Unemployment rate	6.289	2.164	2.600	13.700
Real personal income per capita[h]	10.682	0.153	10.381	11.138
Total VMT per licensed driver (1,000)[i]	2.674	0.174	2.176	3.183
Average precipitation (inches)	37.564	16.927	3.260	84.960
Average temperature (degrees F)	55.978	8.448	40.100	78.700

Notes.
[a] Equals one if a state had a primary ban prohibiting all drivers from using hand-held devices while driving. Primary enforcement allows officers to issue a ticket to a driver without any other traffic offence taking place. Takes on fractional values for the years in which laws changed.
[b] Ban specifically for novice drivers, which typically refers to younger drivers, however the exact definition varies depending on the age or experience of the driver and/or the license status (e.g., probationary licenses or learner's permits). Takes on fractional values for the years in which laws changed.
[c] Equals one if a state had a primary ban prohibiting drivers from texting and zero otherwise. Takes on fractional values for the years in which laws changed.
[d] Strong rating equals one if a state had, for all drivers, both primary handheld and primary texting bans for most of the year and zero otherwise. Moderate rating equals one if a state had, for all drivers, either primary handheld or primary texting ban (but not both) for most of the year and zero otherwise. Weak rating equals one if a state had, either secondary handheld/texting bans for all drivers or primary/secondary handheld/texting bans for novice drivers for most of the year and zero otherwise. None rating equals one if a state had no texting or handheld texting bans (for all or novice drivers) and zero otherwise.
[e] Equals one if a state had a graduated driver-licensing law with an intermediate phase in a given year and zero otherwise. Takes on fractional values for the years in which laws changed.
[f] A universal helmet law requires motorcycle riders of all ages to wear a motorcycle helmet. Takes on fractional values for the years in which laws changed.
[g] Equals one if a state had a primary/secondary enforcement of seat belt law in a given year and zero otherwise. Takes on fractional values for the years in which laws changed. Primary enforcement allows officers to issue a ticket to drivers or passengers for not wearing a seat belt, without any other traffic offence taking place. Secondary enforcement allows officers to issue a ticket to drivers or passengers for not wearing a seat belt only when there is another citable traffic violation (e.g., speeding).
[h] In constant 2015 dollars.
[i] Vehicle miles traveled (VMT) on public roads in 1,000s.

state *s* and year *t*. The vector ***P*** includes various traffic policy measures (including texting/handheld ban ratings), as listed in Table 1. The vector ***X*** contains state- and year-specific characteristics, also listed in Table 1, which could potentially influence traffic safety. Year fixed-effects, represented by λ_t, control for annual secular nationwide trends in traffic safety. State-specific fixed-effects, denoted by δ_s, account for any time-invariant differences in traffic fatalities across states. The indicator variables for texting/handheld ban ratings are the focus in our analysis.

The estimated coefficients are based on least squares regressions weighted by state population. With the natural logarithm of the fatality rate as the dependent variable, the coefficient estimates have a semi-elasticity interpretation (i.e., percentage change in the fatality rate associated with adoption of a *strong*, *moderate*, or *weak* ban relative to no bans). In all estimations, standard errors are clustered to allow for non-independence of observations within each state. For brevity, we omit estimation results for year and state fixed-effects (and sometimes the estimation results for other variables). All of these non-reported estimates can be obtained from the authors upon request. As a robustness check, we also estimate count data models via Poisson regressions that condition on state fixed-effects.

3. Results

Table 2 presents estimation results for motorcyclist fatalities (Columns (1)–(2)) and fatalities in crashes involving no motorcycles (Columns (3)–(4)). The first specification includes the texting/handheld ban ratings, and vectors of year and state fixed-effects. The second and fully augmented model adds other traffic policies and state characteristics. Standard errors are clustered to allow for the non-independence of observations within each state.

Regardless of model, a *strong* ban rating is associated with statistically significant reductions in motorcyclist fatalities. Considering the fully specified model (Column (2)), a *strong* ban leads to an 8.8% reduction in the motorcyclist fatality rate ($p < .05$) and a *moderate* ban leads to a 5.5% reduction ($p < .01$). The estimate for a *weak* ban is much smaller in magnitude and not statistically significant. The other significant predictors for motorcyclist fatalities are a universal motorcycle helmet law (18.5% reduction), unemployment rate (2.6% reduction for a one-point increase in the unemployment rate), average precipitation (0.2% reduction for a one inch increase in average precipitation), and average temperature (3.7% increase for a 1 °F increase in average temperature)—all of which are consistent with the existing literature (e.g., French and Gumus, 2014).

As demonstrated in Columns (3)–(4), *strong*, *moderate*, and *weak* bans also have a negative effect on traffic fatalities involving no motorcycles, but the estimates are relatively small in magnitude and never statistically significant. This result is disheartening yet consistent with other studies in the literature, which find that texting/handheld bans have little or no effect on overall traffic fatalities (e.g., Abouk and Adams, 2013; Bhargava and Pathania, 2013). Considering the fully-specified model (Column (4), primary and secondary enforcement seat belt laws (negative), unemployment rate (negative), personal income per capita (positive), vehicle miles traveled per licensed driver (positive), and average temperature (positive) all have a statistically significant effect on traffic fatalities in crashes involving motor vehicles other than motorcycles. Instead of employing least squares regression to the natural logarithm of the fatality rate, we re-estimated all models in

Table 2
Estimation results for traffic fatalities by crash type, 2005–2015 (N = 550).

	Motorcyclist fatalities		Fatalities in crashes involving no motorcycles	
	(1)	(2)	(3)	(4)
Texting/handheld ban rating: Strong	−0.103* (0.047)	−0.088* (0.037)	−0.067 (0.046)	−0.045 (0.025)
Texting/handheld ban rating: Moderate	−0.051 (0.033)	−0.055** (0.018)	−0.027 (0.030)	−0.015 (0.017)
Texting/handheld ban rating: Weak	0.004 (0.032)	−0.020 (0.026)	−0.005 (0.017)	−0.016 (0.013)
Speed limit ≥ 75mph		0.028 (0.029)		0.011 (0.019)
Graduated driver-licensing law		−0.055 (0.031)		−0.018 (0.030)
Universal helmet law		−0.185** (0.031)		
Seat belt law - Primary enforcement				−0.040* (0.019)
Seat belt law - Secondary enforcement				−0.022** (0.006)
Unemployment rate		−0.026* (0.012)		−0.017* (0.007)
Ln(Personal income per capita)		0.455 (0.319)		0.821** (0.156)
Ln(Total VMT per licensed driver)		0.241 (0.166)		0.235** (0.084)
Average precipitation (inches)		−0.002* (0.001)		−0.000 (0.000)
Average temperature (degrees F)		0.037** (0.007)		0.008* (0.003)

Notes: The dependent variable is the natural logarithm of fatalities per 100,000 people. The estimated coefficients are based on least squares regressions weighted by state population. Each specification also includes a constant, vectors of year and state fixed-effects. Standard errors are in parentheses and are clustered to allow for non-independence of observations within each state. *, ** Significance at the 5 and 1 percent level, respectively.

Table 2 with conditional fixed-effect Poisson regression and the count of fatalities as the dependent variable. These estimates are presented in Appendix Table A2 and are nearly identical in sign and significance to the ones reported in Table 2.

In general, motorcyclists involved in multi-vehicle crashes are much more likely to be victims than at-fault (e.g., Haque et al., 2009). As explained earlier, motorcyclists generally cannot talk or text while riding, so we surmise that these policies are more likely to reduce the prevalence of multiple-vehicle motorcycle crashes compared to single-vehicle motorcycle crashes. To investigate this hypothesis, we consider fatalities in three groups: all crashes, single-vehicle crashes, and multiple-vehicle crashes. We report selected estimation results of least squares regressions based on crash type in Table 3. All estimates are based on models including other traffic policies, state-specific characteristics, as well as year and state fixed-effects.

As we suspected, the significant negative effects of texting/handheld ban ratings on motorcyclist fatalities work largely through multiple-vehicle crashes. Namely, none of the ratings has a significant effect on single-vehicle motorcyclist fatalities. However, both *strong* and *moderate* bans have a statistically significant influence on motorcyclist fatalities involving multiple-vehicle crashes. Moreover, the effect sizes are greater than those pertaining to all motorcyclist fatalities—11.0% reduction in the multiple-vehicle motorcyclist fatality rate for *strong* bans ($p < .01$) and 7.7% reduction for *moderate* bans ($p < .05$). As with single-vehicle non-motorcyclist fatalities, none of the texting/handheld bans have a significant effect. However, a *strong* ban rating has a negative and statistically significant effect on multiple-vehicle non-motorcyclist fatalities (9.4% reduction; $p < .01$).

Table 3
Selected estimation results for traffic fatalities by crash type and number of vehicles involved, 2005–2015 (N = 550).

Panel A: Motorcyclist fatalities	All	Single vehicle	Multiple vehicles
	(1)	(2)	(3)
Texting/handheld ban rating: Strong	−0.088* (0.037)	−0.079 (0.067)	−0.110** (0.038)
Texting/handheld ban rating: Moderate	−0.055** (0.018)	−0.036 (0.032)	−0.077* (0.031)
Texting/handheld ban rating: Weak	−0.020 (0.026)	−0.013 (0.047)	−0.036 (0.026)
Panel B: Fatalities in crashes involving no motorcycles	**All**	**Single vehicle**	**Multiple vehicles**
	(4)	(5)	(6)
Texting/handheld ban rating: Strong	−0.045 (0.025)	−0.016 (0.028)	−0.094** (0.030)
Texting/handheld ban rating: Moderate	−0.015 (0.017)	−0.012 (0.019)	−0.017 (0.021)
Texting/handheld ban rating: Weak	−0.016 (0.013)	−0.011 (0.012)	−0.023 (0.020)

Notes: The dependent variable is the natural logarithm of fatalities per 100,000 people. The estimated coefficients are based on least squares regressions weighted by state population. Each specification also includes a constant, vectors of year and state fixed-effects. Specifications in Panel A(B) include all the other policy and control variables listed in column 2(4) in Table 2. Standard errors are in parentheses and are clustered to allow for non-independence of observations within each state. *, ** Significance at the 5 and 1 percent level, respectively.

4. Discussion and conclusions

When drivers are distracted due to mobile device use, motorcyclists can be especially susceptible to multi-vehicle collisions. The present research is the first study to examine whether texting/handheld bans have a significant effect on motorcyclist fatalities. Analyzing FARS data from 2005 to 2015 coupled with state-specific characteristics and traffic policies, we find that *strong* and *moderate* texting/handheld bans have a significant negative effect on motorcyclist fatality rates, with effect sizes ranging from 5.5% to 10.3%. Additional analyses show that the overall effects are driven mainly by multiple-vehicle crashes rather than single-vehicle crashes. Once again, *strong* (11.0%) and *moderate* (7.7%) bans are significantly related to multiple-vehicle motorcyclist fatality rates, and the magnitudes are larger than for all fatalities. This result provides further evidence that texting/handheld bans are effective in protecting motorcycle drivers and passengers through their impact on other vehicle operators who are much more likely to be distracted by mobile devices.

To provide additional context for the welfare implications of texting/handheld bans, a "back-of the-envelope" calculation may be helpful. In 2015, the last year of our data, 14 states had already adopted *strong* texting/handheld policies according to our rating system (i.e., both primary handheld and primary texting bans for all drivers). Assume that the remaining 36 states, where 3456 total motorcyclist fatalities occurred in 2015, adopted the same set of bans. Based on our estimates in Column (2) of Table 2, such a policy change would have resulted in approximately 173 fewer motorcyclist fatalities across the country in just one year. This is based on a combination of three components: i) 8.8% reduction in 152 motorcyclist fatalities across two states with a ban rating of none; ii) 6.8% (i.e., 8.8%–2.0%) reduction in 1443 motorcyclist fatalities across eight states with a weak rating; iii) 3.3% (i.e., 8.8%–5.5%) reduction in 1861 motorcyclist fatalities across 26 states with a moderate rating. Using $9.4 million as the estimated value of a statistical life—as utilized by the U.S. Department of Transportation (Thomson and Monje, 2015) and also validated by others (Viscusi and Gentry, 2015)—such a policy would result in a public health benefit of $2.86 billion (in 2015 dollars). This social welfare gain only pertains to reduced fatalities, as the total value is likely to be much higher when considering reduced injuries, avoided hospitalizations, and other benefits.

Our study has some data and methodological limitations. First, the longitudinal analysis spans just 11 years, from 2005 to 2015. Although it would be desirable to have a longer panel, changes in texting/handheld policies have happened only very recently as described earlier. Future studies should consider longer periods and examine long-term effects of these policies, as they may be different from the short-term effects. Second, we include several traffic policy variables and state characteristics as controls, but omitted variables, such as police enforcement and cellphone use, could potentially confound the effects of texting/handheld policies on traffic fatalities. Third, our rating system for texting/handheld bans is still somewhat arbitrary as we were unable to find any established or accepted rating systems in the existing literature. This particular rating algorithm may not sufficiently capture all the nuances regarding various policies and their enforcement. Another shortcoming is that we lack state-specific information on penalties or fines associated with violating texting/handheld bans. Finally, we are unable to investigate non-fatal injuries and hospitalizations, even though these tend to be far more common compared to fatal motorcycle injuries (e.g., French et al., 2009).

When conducting rigorous public policy analysis, it sometimes appears that well-intentioned laws result in little or no impact on public health. This certainly holds true in the case of texting/handheld bans while driving as much of the literature reports no statistically significant or practically meaningful effects on overall traffic fatalities. However, we decided to further investigate these policies by focusing specifically on motorcyclist fatalities. The results of this subgroup analysis show that motorcyclists greatly benefit from texting/handheld policies as both *strong* and *moderate* bans have a statistically significant and relatively large negative impact on motorcyclist fatalities caused by multiple-vehicle crashes.

Although this relatively large and robust subgroup effect may seem to generate only a modest impact on public health and social welfare, existing statistics suggest otherwise. Motorcyclist fatalities actually represent a serious public health issue affecting thousands of people each year because motorcycles make up only 3% of registered motor vehicles yet 14% of all traffic fatalities (NHTSA, 2017b; Federal Highway Administration, various years). Between 2005 and 2015, the number of registered motorcycles in the U.S. increased almost 40% as motorcycling has become a popular mode of transportation for workplace commuting, running errands, vacationing, and other forms of recreation (Federal Highway Administration, various years; Federal Highway Administration, various years). Considering that reductions in mortality from traffic fatalities has been slower to materialize in the U.S. in comparison to other high-income countries, improving motorcycle safety could make a meaningful difference.

Our estimates suggest that, in 2015 alone, adopting both primary handheld and primary texting bans for all drivers (i.e., *strong* rating) in the entire country could have prevented approximately 173 motorcyclist fatalities. Even the adoption of *moderate* texting/handheld policies (i.e., either primary handheld or primary texting ban for all drivers) among states that had a *weak* or no-ban rating could have prevented up to 59 motorcyclist fatalities across the U.S. in a single year. To provide additional context, based on our estimates, enacting universal helmet laws across the entire country could have prevented about 535 lives (18.5% reduction in 2894 total motorcyclist fatalities in states without a UHL) during the same year. Thus, strengthening texting/handheld policies can have relatively sizeable effects on traffic safety for motorcyclists, even though the effects on overall traffic safety are less pronounced. Given the relatively recent adoption of texting/handheld bans in most states, more time is needed to distinguish between the short-term and the long-term effects of these policies on overall and specific types of traffic safety, which we believe is a valuable avenue for future research.

With overwhelming public support for *strong* texting/handheld bans that are aggressively enforced, it is surprising that only 14 states had a *strong* ban rating in 2015. Even with *strong* bans in place, however, many drivers blatantly break the law by continuing to use their cellphones while driving. This could be at least partly due to lax state enforcement as citations for cellphone use while driving comprised only 1% of all traffic citations between 2007 and 2013 (Rudisill and Zhu, 2016). Some states have tried to address this dangerous behavior through innovative approaches such as road-safety campaigns, text-free rest zones, high-visibility enforcement, and other behavior-modification technological nudges such as cellphone applications that block use while driving (e.g., Chaudhary et al., 2015; Creaser et al., 2015). The city of Philadelphia actually extended handheld bans to non-motorists, including bicyclists and skaters. Policy advocates have called upon automakers to refrain from installing communication systems in motor vehicles and instead adopt technologies to block mobile devices while the vehicle is in motion (e.g., Jacobson and Gostin, 2010). Perhaps findings from this study will further mobilize policy makers, law enforcement officials, and the general public to get tough on cellphone use and all other forms of distracted driving.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2018.09.032.

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