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Cell Phones and Motor Vehicle Fatalities

Erich Muehlegger[a], Daniel Shoag[a,*]

[a]*Harvard Kennedy School, Harvard University, 79 John F. Kennedy St, Cambridge, MA 02138, USA*

Abstract

We examine real-world data on 6,700 motor vehicle crashes and data on cell phone usage in a mid-sized European country. In a non-experimental context, we document a positive correlation at the cell-tower level between call volumes and the likelihood of a nearby motor vehicle accident leading to a serious injury. We demonstrate that these correlations are robust to a series of controls. Scaling our estimates by the number of crashes in our data, we estimate that a 100% increase in call volumes is associated with a 15% to 43% increase in the likelihood of a serious crash.

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1. Introduction

Smart phones, cell phones and other mobile devices have dramatically changed many aspects of society. In March 2012, the Pew Internet and American Life Project (http://www.pewinternet.org/) surveyed American adults and found that over 88% of American adults surveyed owned a cell phone and more than half owned a smart phone. Relatively to the previous year, smart phone usage rose amongst all major demographic groups. Ownership of other mobile devices has increased substantially as well. 57% of those surveyed owned a laptop and 19% owned a tablet computer.

One particularly relevant policy question is how the use of mobile devices affects driver safety. Cell phone use while driving is thought to be extremely common. In "Distracted Driving: What Research Shows and What States Can Do," the Governors' Highway Safety Association (GHSA) estimates that 7-10% of drivers are using a cell phone at any point in time and that cell phone use is a significant contributor to automobile accidents (15-30% of vehicle crashes involve at least one distracted driver). In response to concerns about the safety of distracted drivers, forty-five states have laws regulating the use of cell-phones while driving.

Despite the substantial concern of policy makers, relatively little consensus has been reached on the impact of distracted driving on safety. Academic studies employ a variety of approaches, from driver simulations to econometric estimates exploiting cell phone plan contract structure and reach an equally wide range of results, from estimates that suggest driver distraction and cell phone use increase accidents substantially to estimates that suggest cell phone use

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* Corresponding author.

  E-mail address: Daniel_Shoag@hks.harvard.edu.

has little impact. But, to our knowledge, none of the these studies directly observe primary data on cell phone use and match information with data on vehicle crashes or fatalities.

We bring direct evidence to bear on this important public health and safety question by examining the relationship between accidents and directly observed data on cell phone call volumes at the local level. For more than two thousand cell phone towers, we observe hourly call volumes as well as whether there nearby vehicle accident that led to a serious injury or fatality.

1.1. Previous Literature

Our research will make several contributions to the existing literature examining the relationship between mobile device use and driver safety.

First, our empirical approach (detailed below) will enable us to more cleanly estimate the causal relationship between device use and crashes. Although a number of papers have studied the effect of cell phones on driver safety, no approach to date cleanly estimates the causal impact of mobile device use on driver safety based on real-world driving behavior. The existing literature has produced a wide range of results - from estimates that suggest driver distraction and cell phone use greatly increase accidents substantially to estimates that suggest cell phone use has little impact.

Previous research on the topic has approached the question in one three ways. First, a number of studies compare fatalities before and after state enactment of legislation designed to limit drivers' use of cell phones. These studies tend to find modest effects of cell phone regulation - but cannot measure enforcement or actual cell phone use. If enforcement is imperfect, these studies may substantially understate the relationship between driver distraction and driver safety.

A second set of research attempts to overcome this shortcoming by surveying drivers to elicit information about distracted driving or using after-crash police observation. As examples, McEnvoy et. al. (2005) and Redelmeier and Ticshirani (1997) use cell phone records of a small sample of consenting drivers to see if these drivers had been on the phone immediately prior to a crash. If crash victims using cell phones are unwilling to admit cell phone use, both driver surveys and police observation likely understate the fraction of drivers who use cell phones. A handful of other papers find little causal evidence between distracted driving and driver safety. Violanti and Marshall (1996) , Laberge-Nadeau et. al. (2003) , and Hahn and Prieger (2007) find that drivers who use cell phones tend to be higher risk drivers. A final set of studies have tried to experimentally establish the relationship between driver distraction and safety. These studies have typically used driving simulators to measure reaction times and driver safety in a controlled laboratory environment. While informative, these are unlikely to measure the impact on real-world driving behavior.

Our approach improves on the existing literature in several ways. As we discuss in the methodology section below, our work will: (1) measure real-world crash outcomes, (2) use information on all police reported traffic accidents, and (3) use real-time detailed information on cell phone use to estimate the overall population risks imposed by cell phone use without relying on self-reporting or artificial lab conditions. This will allow us to more cleanly estimate the relationship between cell phone use and driving outcomes.

Our approach also allows us to better understand the risk that distracted driving poses for nearby drivers. Even if many drivers comply with a cell-phone ban, a small number of distracted drivers may still create large risks for non-distracted drivers. By capturing the effects on both the distracted driver and other drivers, the paper better captures the welfare-relevant consequences of cell phone use.

2. Data and Methodology

Our traffic accident data come from the national road safety authority of a mid-sized European country, and they include information on 3,548 accidents in 2006 and 3,155 in 2007. The data only record accidents involving serious injuries or deaths. The data include a detailed time stamp, a roadside location, and a description of the cause of the accident. We were able to successful geocode more than 70% of these accidents using Google's geocoding API.

We match this dataset to a proprietary dataset of a nationwide mobile phone carrier for that same country. The data are call data records that contain the call time, duration and tower locations and scrambled identifiers for each

recipient and caller. The carrier has roughly 15% market share, and the data set spans a 15-month period between 2006 and 2007, with the exception of a 6 week gap due to data extraction failures.

We collapse the data to tower-hour level, yielding a data set of 22.5 million observations. The average tower hour has 37.1 calls, but this distribution has a long right tail - the median tower hour features only 10 calls. In total, we have 2,056 unique towers in the data and 830 million calls.

To estimate the results we match accidents to the nearest tower and construct outcomes for neighborhoods of fixed distances for each tower. Our unit of observation is thus the tower-hour, and we limit the sample to tower-hours with at least one call. Since multiple accidents rarely occur near the same tower in the same hour[1], we use a dummy variable for whether or not an accident occurred within a particular distance from the tower as our dependent variable and estimate the following linear probability model:

$$Accident_{iht} = \beta LogCalls_{iht} + \epsilon_{iht} \tag{1}$$

where i denotes the tower, h denotes the hour of the week, and t denotes time.

Our preferred specification includes tower*hour-of-the-week fixed effects and estimates the coefficient of interest, β, off of within tower*hour-of-the-week variation. Effectively, we compare accidents near a particular tower in a particular hour of the week to the same tower and hour of week in other weeks. Our specification tests whether accidents are more likely at times when call volumes are high than when call volumes are low.

3. Results

Table 1 presents the results of our linear probability models, where the coefficients are divided by the dependent variable mean. In column 1 we use a radius around towers of 1 mile and in column 2 we use a radius of 0.25 miles. Columns 1 and 2 presents the results without additional control variables. We estimate that a 100% increase in call volume roughly corresponds to an increase in the probability of a major accident of 4.3%. This effect is slightly larger over the larger radius, and it is statistically significant at conventional levels at that distance.

Table 1. Cell Phones and Motor Vehicle Accidents

	(1)	(2)	(3)	(4)	(5)	(6)
Log(Calls)	0.052***	0.043	0.003	0.155*	.003	.434*
	(0.018)	(0.029)	(0.005)	(0.085)	(.003)	(.236)
Tower Radius (miles)	1	0.25	1	0.25	1	0.25
Specification	-	-	FE	FE	IV + FE	IV + FE
Observations	16914186	16914186	16914186	16914186	169112070	169112070

Notes: Columns 3, 4, 5, and 6 include tower*hour-of-week fixed effects.
*,**,*** denote significance at the 10%, 5%, and 1% level, respectively.

One concern with these results is that they fail to account for differences in congestion or traffic across tower-radii. To correct for that, we include fixed effects for tower and hour of the week in Columns 3 and 4. These controls should correct for bias due to baseline differences in road usage that do not change over time. We see in these columns that, while the precision of the estimates is somewhat weakened, we still see a sizable correlation between cell phone use and serious accidents. The coefficient within .25 miles is now quite large (a 15% increase for a doubling of call volume).

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[1] Of the 5055 crashes for which we know both the location and the time, only 11 occur nearest to the same tower in the same hour.

These results are the first direct evidence linking call patterns and accidents in a non-experimental setting. As expected, the observational data strongly confirm the link between traffic injuries and death and mobile phone use.

3.1. Controlling for Traffic Volumes

Two potential concerns exist with the previous approach. First, although we include tower*hour-of-week fixed effects that account for roughly 80% of the variation in calls in the data, if traffic volumes are positively correlated with the remaining variation in both cell phone volumes and vehicle fatalities, we may overstate the true relationship between cell phone use and vehicle fatalities. Second, the previous results do not cleanly identify the causal channel connecting call volumes to vehicle fatalities - the results in the first four columns imply that as accidents near to a tower are more likely when call volumes are high at that tower. Although experimental evidence suggests that cell usage may cause vehicle crashes, the observational results reported in Table 1 do not rule out causal stories operating in the reverse direction. For example, if crashes lead people to use their cell phones, we would expect a similar positive correlation between call volumes and accidents.

To address both of these concerns, we instrument for local cell phone volumes using cell phone volumes in distant urban areas.

Consider the following first-stage:

$$LogCalls_{iht} = \alpha_{ih} + \beta_0 Traffic_{iht} + \beta_1 LogCalls_{-iht} + \epsilon_{iht} \tag{2}$$

For non-local call volumes to be a legitimate instrumental variable for local call volumes, non-local call volumes must be correlated with local call volumes but uncorrelated with the residual variation in equation (1). The first requirement is plausibly satisfied if call volumes nationwide are driven by news or other events that exogenously shift call volumes in more than one location. Focusing on traffic volumes as the primary source of omitted variable bias, the exclusion restriction requires non-local call volumes to be uncorrelated with local traffic volumes conditional on tower-day of the week-hour fixed effects.

To construct non-local call volume, we measure total calls for each hour nationally, and subtract call volumes for all towers whose longitude and latitudes have the same whole number. In our first stage regressions of hourly log tower calls on the logged measure of non-local calls we find that, even conditional on the fixed effects, the first stage t-statistic exceeds 1000. We are not concerned about a weak instrument.

Our 2SLS results for both 1 and .25 miles are presented in columns 5 and 6 respectively. The results are scaled as in the previous regressions. We find that a 100% increase in calls is associated with an enormous 43% increase in the likelihood of a crash at .25 mi, and a much more modest 0.3% at 1 mile. Only the first result is statistically significant at the 10% level. Still, the fact that volume is positively associated with crashes even after controlling for so much variation and removing threats to internal validity due to traffic flows is quite reassuring about the relationships found in the prior statistical models.

4. Discussion

Though dozens of countries and multiple states have banned the use of mobile phones while driving, we are unaware of any prior direct evidence linking total cell phone usage volume to real-world accidents. This paper compliments a growing literature by documenting these associations in data in a non-experimental context and shows that the correlations are robust to a series of controls. This data also opens up a new window on the relationship between phone usage and accidents. Future research will explore heterogeneity in these effects, and disentangle the effects associated with incoming and outgoing calls. We believe that the data and framework established here provide a nice illustration of the research that can be done on humanitarian consequences of technology in social science.

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