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ABSTRACT

This study contributes to the literature on supply-side adjustments to insurance expansions by examining the effect of the Affordable Care Act (ACA) on ambulance response times. Exploiting temporal and geographic variation in the implementation of the ACA as well as pre-treatment differences in uninsured rates, we estimate that the expansions of private and Medicaid coverage under the ACA combined to slow ambulance response times by an average of 19%. We conclude that, through extending coverage to individuals who, in its absence, would not have availed themselves of emergency medical services, the ACA added strain to emergency response systems.

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1. INTRODUCTION

Ever since the publication of Arrow's (1963) seminal article, economists have explored and deliberated the appropriate role of government in health insurance markets. With the passage of the Patient Protection and Affordable Care Act (ACA) in 2010 and subsequent, high-profile repeal efforts, this question has also risen to the forefront of public policy debates. While the effects of health insurance expansions on utilization and other patient outcomes have been studied extensively, less attention has been paid to the supply-side of the market and whether provider capacity constraints create challenges as the demand for medical care increases. The current study explores one of the potential supply-side challenges caused by expanding insurance coverage. Specifically, our interest is in estimating the effect of the ACA on ambulance response time, defined as the time elapsed between notification and when the first ambulance arrived on the scene of a motor vehicle accident.

The ACA was intended to achieve nearly universal health insurance coverage through a combination of insurance market reforms, mandates, and government subsidies. In an effort to provide access to affordable coverage for patients with pre-existing conditions, insurers operating in the non-group insurance market were prohibited from denying or dropping coverage, pricing based on health (aside for limited adjustments for age and smoking status), setting lifetime caps, and offering sub-standard benefits. Because these regulations on their own would likely have led to adverse selection, the ACA required that individuals obtain insurance coverage or pay a tax penalty. The ACA also expanded Medicaid to 138% of the Federal Poverty Line (FPL), while providing subsidies for purchasing coverage through private insurance

"Marketplaces" (Gruber, 2011).[1] A 2012 Supreme Court decision made the Medicaid expansion component of the ACA optional, and, as of May 2017, 19 states had opted out.

A number of studies have documented a sharp increase in health insurance coverage in 2014, the year in which the major components of the ACA took effect (Long et al., 2014; Smith and Medalia, 2015; Barnett and Vornovitsky, 2016; Courtemanche et al., 2016; McMorrow et al., 2016). Using American Community Survey (ACS) data through 2014, Courtemanche et al. (2017a) found that the ACA increased health insurance coverage by 6 percentage points in states that expanded Medicaid and by 3 percentage points in the 19 non-expansion states. Using an additional year of ACS data (i.e., 2015), Frean et al. (2017) concluded that the expansion of state Medicaid programs accounted for 60% of the coverage gains under the ACA, while the remaining 40% could be attributed to the subsidies offered through the private insurance exchanges.[2]

Expanding health insurance coverage should, in theory, increase the amount of medical care demanded by reducing its out-of-pocket price. The extent to which this increase actually translates into health care utilization depends, however, on the supply-side response, which could be limited by barriers to entry such as licensing requirements, the capital costs of medical facilities and equipment, and the extensive regulations governing the construction of new medical facilities. A substantial body of research has shown that the United States is currently experiencing acute shortages of health care providers, particularly in the primary care sector (Ku et al., 2009; Bodenheimer and Pham, 2010; Juraschek et al., 2012; Dall et al., 2017), and

[1] The ACA also included many other components such as mandates for employers to provide coverage and for insurers to allow dependents to remain on parents' plans until age 26, changes to Medicare financing, and tax increases on high-income individuals and medical devices. The Kaiser Foundation has published a useful guide to the ACA (Kaiser Family Foundation 2017a).

[2] Other studies that have investigated the effects of the ACA on coverage include Kaestner et al. (2015) and Wherry and Miller (2016), both of which focused on the effect of expanding state Medicaid programs.

projections indicate that these shortages will be exacerbated as a result of the ACA (Ku et al., 2009; Sargen et al., 2011; Huang and Finegold, 2013). If health care providers cannot meet the additional demand for their services generated by expanding insurance coverage, both newly insured patients and patients who were previously covered might experience difficulty in accessing care, undermining the case for expansion (Hofer et al., 2011; Kirch et al., 2013; Miller and Wherry, 2017).

Considerable evidence – dating back to the RAND Health Insurance Experiment of the 1970s and 1980s (Manning et al., 1987) – suggests that expanding health insurance coverage encourages utilization, consistent with the fact that coverage lowers the effective price of medical care. This literature has explored the effects of several important policy interventions. In the United States alone, these interventions include Medicaid (Currie and Gruber, 1996a; Dafny and Gruber, 2005; Baicker et al., 2013; Finkelstein et al., 2012; Taubman et al., 2014; Tello-Trillo, 2016), Medicare (Lichtenberg, 2002; Card et al., 2008), the Massachusetts universal coverage initiative (Miller, 2012a; Kolstad and Kowalski, 2012; Van der Wees et al., 2013), the 2010 expansion of coverage to young adults under the ACA (Sommers et al., 2013; Antwi et al., 2015; Barbaresco et al., 2015) and the various ACA provisions that took effect in 2014 (Sommers et al., 2015; Courtemanche et al., 2017b; Simon et al., 2017; Miller and Wherry 2017).[3]

Whether increased utilization actually results in better health outcomes of patients is, however, still an open question. There is strong evidence that the expansion of private insurance coverage under the Massachusetts reform led to sizeable improvements in self-assessed health and reductions in emergency room use (Kolstad and Kowalski, 2012; Miller, 2012b; Van der

[3] In a related study, Brot-Goldberg et al. (2017) documented an decrease in several aspects of health care utilization, including emergency services, among employees of a large self-insured firm after a transition from free health care to a high-deductible plan.

Wees et al., 2013; Courtemanche and Zapata, 2014). By contrast, despite improving self-assessed health, the randomized Oregon Medicaid expansion had little to no impact on clinically measured health outcomes, and actually led to an increase in emergency room utilization (Baicker et al., 2013; Finkelstein et al., 2012; Taubman et al., 2014). The private insurance portion of the ACA seems to have improved access to care, but the evidence with regard to its effect on self-assessed health is decidedly mixed (Sommers et al., 2015; Courtemanche et al., 2017b). Several studies have found that the Medicaid expansion under the ACA led to modest access gains for patients, but had no discernable effect on self-assessed health (Sommers et al., 2015; Courtemanche et al., 2017b; Simon et al., 2017).

Despite the potential importance of capacity constraints in explaining the heterogeneous effects of insurance coverage expansions described in the paragraph above, only a handful of previous studies have focused on the supply-side of the market.[4] Garthwaite (2012) concluded that physicians responded to the State Children's Health Insurance Program (SCHIP) by shortening office visits, while Kolstad and Kowalski's results suggest that the 2006 Massachusetts reform led to shorter hospital stays. Kondo and Shigeoka (2013) found that hospitals increased their capacity (as measured by number of beds) after the introduction of universal health insurance in Japan, but there were no noteworthy changes in the numbers of medical institutions, physicians, or nurses. Buchmueller et al. (2014) examined provider behavior and patient wait times before and after several states expanded their Medicaid programs to include dental benefits. These authors found that the use of hygienists increased when

[4] If providers are unable to fully meet new demand, they may give priority to more lucrative privately insured patients, potentially explaining the heterogeneous effects of insurance expansions. Moreover, if capacity constraints are less binding in wealthy states, this could explain why the expansion of private insurance coverage under the Massachusetts reform led to sizeable improvements in self-assessed health and reductions in emergency room use, while the Oregon Medicaid expansion led to an increase in emergency room use (Courtemanche et al., 2017b).

coverage was expanded, but dentists also responded by increasing their own work effort. Nonetheless, wait times for patients rose “modestly” (Buchmueller et al., 2014, p. 3).[5]

We contribute to the small but growing literature on supply-side adjustments to insurance expansions by investigating the effect of the ACA on ambulance response times. Our work provides the first estimates of the effect of coverage expansion under the ACA on wait times for any type of medical service.[6] Moreover, although a literature exists on emergency room wait times and the practice of diverting ambulances to other hospitals in an effort to avoid overcrowding (e.g. Schull et al., 2003; Wilper et al., 2008), only one previous study, by David and Harrington (2010), has explored the determinants of ambulance response times, and these authors did not examine the effects of expanding insurance coverage.[7]

Both Medicaid and Marketplace plans cover emergency medical services (Folger, 2015),[8] and enrollment in a public insurance program was a strong predictor of using ambulance transport to the emergency room prior to the passage of the ACA (Rucker et al.,1997; Larkin et

[5] See also Friedson and Marier (2017), who described an influx of out-of-state physicians during the implementation of the Massachusetts reform, a solution to capacity limitations that is clearly less viable in the case of a nationwide reform such as the ACA. Using data from National Health Interview Survey, Miller and Wherry (2017) examined the effect of Medicaid expansions under the ACA on various measures of access to care. These authors found that low-income individuals living in expansion states were less likely to be shut out of care due to cost concerns, but were more likely to delay care because they could not make an appointment with a physician.

[6] Polsky et al. (2015) found evidence that the temporary increase in the Medicaid reimbursement rate to primary care providers under the ACA shortened wait times for enrollees, but these authors did not study the effect of coverage expansions under the ACA.

[7] David and Harrington (2010) examined the influence of county demographics on ambulance response times. See also David and Brachet (2011, p. 107), who examined the effect of “human capital accumulation” among EMS workers on out-of-hospital time, which is defined as the time between ambulance dispatch and the return to the hospital.

[8] Under the ACA, all health insurance plans offered to individuals both through exchanges and employers are required to provide coverage for an Essential Health Benefits (EHB) package, which includes emergency ambulance services (Folger, 2015). Emergency ambulance services are also covered by every state’s Medicaid program.

al., 2006).[9] If demand for ambulance services increased as a result of the ACA, there are several reasons to suspect that the supply-side response may have been muted, particularly in the short run. First, EMS personnel require considerable education and training, as well as certification, and there is evidence that shortages of these personnel existed even before the ACA took effect (Halpern, 2010).[10] Second, new ambulances can cost between $100,000 and $200,000, representing a major investment for emergency medical service providers (Lindberg, 2011). Finally, relative to, for instance, primary care physicians or dentists, the capital-intensive nature of ambulance services makes meeting new demand through working longer hours more difficult, and shortening visits in an effort to accommodate more patients is not an option available to EMS providers. Because the ACA was fully implemented only recently, we cannot explore its long-run impact on ambulance response times.

We begin by revisiting the effect of the ACA on insurance coverage, which can be thought of as our first stage. Following Courtemanche et al. (2017a), we draw upon ACS data and adopt an identification strategy that exploits temporal and geographic variation in the implementation of the ACA as well as pre-treatment differences in uninsured rates. There are, however, two key differences between our analysis and that of Courtemanche et al. (2017a). First, we use pre-ACA insured rates at the county level rather than the core-based statistical area (CBSA) level. Second, we add a second year (2015) of post-treatment data. Not surprisingly, our results are quite similar to those of Courtemanche et al. (2017a). We find that the ACA increased health insurance coverage by 5 percentage points in states that expanded Medicaid and

[9] Also see Ellis, Martins and Zhu (2017). Using data on 171 million person-months from MarketScan, the authors found a price elasticity of demand for ambulance services of -1 among "forward-looking" individuals, suggesting that extending insurance coverage under the ACA would increase utilization of ambulance services. Accordingly, based on data from the National 911 Program (2014; 2015; 2016), we compute that 911 calls rose by 9% in the first two years after full ACA implementation.

[10] Below, we test directly for changes in levels of EMS personnel in response to the implementation of the ACA.

by three percentage points in non-expansion states. The effect of the ACA on insurance coverage appears to have been stronger in 2015 than it was in 2014.

Next, we turn our attention to the impact of the ACA on ambulance response times using data from the Fatality Analysis Reporting System (FARS) for the period 2010-2015 and the same research design as was used to estimate the effects of the ACA on health insurance coverage. We find that the ambulance response times increased substantially with the implementation of the ACA. Specifically, our preferred estimates suggest that the expansions of private and Medicaid coverage under the ACA combined to slow ambulance response times by almost two minutes, or approximately 19 percent at the average uninsured rate. Because we find no evidence that this increase can be explained by traffic congestion or local economic conditions, we conclude that, through extending coverage to individuals who would have otherwise not availed themselves of emergency medical services, the ACA led to a substantial increase in ambulance response times.

2. THE ACA AND INSURANCE COVERAGE

As noted in the introduction, several recent studies have examined the effect of the ACA on health insurance coverage (Courtemanche et al., 2017a; Courtemanche et al., 2017b; Frean et al., 2017).[11] Our interest in re-visiting this effect is twofold. First, we want to update the Courtemanche et al. (2017a) estimates using information from the 2015 wave of the ACS, to which these authors did not have access. Second, and more importantly, we want to exploit pre-ACA differences in uninsured rates at the county, as opposed to the PUMA or CBSA, level

[11] Courtemanche et al.'s (2017b) focus was on estimating the effects of the ACA on access, risky health behaviors such as drinking and smoking, and self-reported health. Frean et al. (2017) examined the effect of the various ACA provisions (exchange premium subsidies, expanding Medicaid, and the individual mandate) on insurance coverage using ACS data for the period 2012-2015.

because there are typically multiple ambulance response zones within a particular PUMA or CBSA (Emergency Medical Services Authority of California, 2013; North Dakota Department of Health, 2009; Central Region EMS and Trauma Care Council 2017) and the county is the finest geographic unit available to researchers using the publicly available SAHIE data.[12] The first-stage estimates, therefore, both motivate our subsequent analyses and add to the literature on the ACA and coverage.

Specifically, we use county-level data on insurance coverage rates from 2010-2015 from the Small Area Health Insurance Estimates (SAHIE) program to estimate the following difference-in-difference (DD) regression equation using Ordinary Least Squares (OLS):

$$(1) \quad Insured_{cst} = \alpha_0 + \alpha_1 Post_t + \alpha_2 \, (Post_t \text{ x } Medicaid\ Expansion_s) + \theta_c + \varepsilon_{cst},$$

where the dependent variable, $Insured_{cst}$, is equal to the proportion of residents living in county c and state s who were covered by health insurance in year t, and $Post_t$ is an indicator equal to 1 in the years 2014 and 2015 (and equal to 0 otherwise).[13] Although a few components of the ACA

[12] Frean et al. (2017) used pre-ACA Medicaid eligibility rates at the Public Use Microdata Area (PUMA) level. The United States contains 2,071 PUMAs, each of which has at least 100,000 people. Courtemanche et al. (2017a) calculated pre-ACA uninsured rates at the core-based statistical area (CBSA) level, while Courtemanche et al. (2017b) divided states into 4 areas (urban, suburban, non-MSA, and unknown). Eighty percent of PUMAs, "map into precisely one CBSA", while the remainder map into two or more CBSAs (Courtemanche et al., 2017a, p. 183). State or local governments typically work with ambulance operators to create semi-exclusive response zones. The size of these zones can vary, but are typically much smaller than a PUMA. For example, the county of Los Angeles has over 30 ambulance response zones and the city of Los Angeles has 7 response zones, while nearby (and largely rural) Kern county has 11 ambulance response zones.

[13] The SAHIE insurance coverage estimates are based on ACS, which uses the 1% sample of Census respondents. Our sample is restricted to counties with a population of more than 10,000, ensuring that the estimated pre-treatment uninsured rate is based on at least 100 individuals in each county. ACS respondents are asked if they are currently covered by "any of the following types of health insurance or health coverage plans", where the choices include "insurance though a current or former employer or union," "insurance purchased directly from an insurance company," "Medicare," "Medicaid, Medical Assistance, or any kind of government-assistance plan for those with low incomes or a disability," "TRICARE or other military health care," "VA (including those who have ever used or enrolled for VA health care)," "Indian Health Service," and "any other type of health insurance or health coverage plan." Only those respondents who answered "no" to every type of insurance listed above are considered by the

took effect in 2010 (most notably, the requirement that dependents be allowed to stay on their parents' private insurance plans until the age of 26), the major components of the ACA came into effect on January 1, 2014. $Medicaid\ Expansion_s$ is an indicator equal to 1 if state *s* expanded its Medicaid program under the ACA, and equal to 0 if it did not.[14] Because county fixed effects, θ_c, are included, the Medicaid expansion indicator does not appear on the right-hand side of equation (1) except when interacted with $Post_t$. Standard errors are corrected for clustering at the state level and all county-year level regressions are weighted by county population in the 2010 census.

Estimates of equation (1) are reported in the first column of Table 1. Taken at face value, they suggest that full implementation of the ACA led to a 5.7 percentage point increase in coverage, while coverage went up by 4.3 percentage points in non-expansion states. However, as noted by Courtemanche et al. (2017a, p. 187), estimates of α_1 and α_2 are suspect both because insurance rates tend to fluctuate over time and because the decision to expand Medicaid expansion could have been correlated with the unobserved determinants of these fluctuations.

Given these issues, we report estimates of the following equation in the second column of Table 1:

$$(2)\quad Insured_{cst} = \beta_0 + \beta_1\,(Post_t \times Uninsured2013_c) + \beta_2\,(Post_t \times Uninsured2013_c \times Medicaid\ Expansion_s) + \theta_c + \gamma_{st} + \varepsilon_{cst},$$

SAHIE program to have been uninsured. For more information on how the SAHIE are calculated see Bauder, Luery and Szelepka (2017).

[14] Twenty-four states and Washington D.C. expanded their Medicaid programs on January 1, 2014. Seven states expanded their Medicaid programs after this date. When interacted with $Medicaid\ Expansion_s$, the variable $Post_t$ was coded as 1 if a state expanded their Medicaid program at any point during year *t*. We experimented with coding $Post_t$ as fraction of the expansion year (for example coding Michigan, which expanded on April 1, 2014 as .75 in 2014 and 1 in 2015). The results were essentially unchanged from those reported in Tables 1-9.

where *Uninsured2013*$_c$ is equal to the proportion of residents living in county c who had coverage in 2013 and state-by-year fixed effects, γ_{st}, account for shocks to coverage at the state-year level.[15] Equation (2) is analogous to a standard difference-in-differences-in differences (DDD) equation, but instead of using an untreated control group, the effect of treatment (i.e., Medicaid expansion and the opening of the private insurance exchanges) depends upon the pre-ACA uninsured rate in county c.[16] Specifically, the effect of the ACA in non-expansion states is given by β_1 x *Uninsured2013*$_c$, while the effect of the ACA in expansion states is given by $(\beta_1 + \beta_2)$*Uninsured2013*$_c$. These effects are calculated at the mean of the pre-ACA uninsured rate, $\overline{Uninsured2013_c}$, or 0.179.

Estimates of equation (2) confirm that the ACA had a strong positive effect on coverage: the estimates of β_1 and β_2 are positive and significant at conventional levels. At the mean of *Uninsured2013*$_c$, we calculate that non-expansion states experienced an increase of three percentage points in their rate of coverage, while expansion states experienced an increase of 5 percentage points; expanding Medicaid without implementing the other major components of the ACA is associated with a 2.1 percentage point increase in coverage.

In Table 2, we explore whether the effect of the ACA on insurance coverage rates changed between 2014 and 2015. Specifically, we report estimates of a modified equation (2), in which the variable *Post*$_t$ is split into two separate indicators, one for 2014 and the other for 2015. Consistent with the results of Frean et al. (2017), we find evidence that the effect of ACA on

[15] Because state-by-year and county fixed effects are included, the variables *Post*$_t$ and *Uninsured2013*$_c$ do not appear on the right-hand side of equation (2) except when interacted with each other.

[16] Several previous studies have used a similar estimation strategy to examine the effects insurance expansions and contractions. A non-exhaustive list of examples includes: Finklestein and McKnight (2008), Miller (2012b), Mazumder and Miller (forthcoming), Tello-Trillo (2017), and Courtemanche et al. (2017a).

insurance coverage grew over time. We calculate that, at the mean of $Uninsured2013_c$, non-expansion states experienced a 3.7 percentage point increase in their rate of coverage by 2015, while states that did expand their Medicaid program under the ACA experienced a 6.3 percentage point increase. These estimates are significantly larger than the estimates for 2014, the year in which the ACA took effect.

3. THE ACA AND AMBULANCE RESPONSE TIMES

Having established the effect of the ACA on coverage, we now turn our attention to the effect of the ACA on ambulance response times. Our data come from FARS and cover the period 2010-2015. Collected by the National Highway Traffic Safety Administration, the FARS data represent an annual census of fatal injuries suffered in motor vehicle crashes (MVCs) in the United States.[17] Although insurance coverage clearly increased during the period under study, EMS providers may not have had enough time or money to increase capacity. Thus, the estimates discussed below should be thought of as short-run. In the long-run, providers could, in theory, respond to increased demand by employing more EMS workers and ambulances.

Detailed accident-level information is available in FARS, including the hour and minute an accident occurred, the hour and minute EMS was notified, the hour and minute the first ambulance arrived at the scene, and the hour and minute the first ambulance arrived at the hospital.[18] However, notification and/or arrival times are missing for approximately 45% of the

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[17] An accident is included in the FARS data if someone involved died within 30 days for reasons attributed to the accident (National Highway Traffic Safety Administration 2016).

[18] The National Highway Traffic Safety Administration obtains information on fatal vehicular accidents from a variety of sources, including police crash reports, vehicle registration files, state highway department data, emergency medical services records, police reports, toxicology reports, and death certificates. Ambulance response times are measured as the difference between when an EMS provider was notified and the time of arrival at the scene of the accident. FARS also includes information on when the ambulance returned to the hospital after the accident.

MVCs in FARS during the period under study. In Appendix Table A1, we test for whether the implementation of the ACA was associated with the probability that these times were missing using a DDD-style strategy similar to equation (2). This exercise produced estimated coefficients that are, without exception, small and statistically insignificant at conventional levels, suggesting that selection is not an issue.

If the implementation of the ACA did in fact lead to longer ambulance response times, the results of several medical studies provide evidence that this phenomenon would have decreased the odds of survival for MVC victims. For instance, Gonzalez et al. (2009) analyzed data on MVCs and patient outcomes in Alabama for the period 2001-2002. These authors found little evidence of a relationship between ambulance response times and the likelihood of survival in urban areas, but in rural areas this relationship was negative and significant.[19] Durkin et al. (2005), Zwerling et al. (2005), and Li et al. (2008), and Sánchez-Mangas et al. (2010) provide additional evidence of a negative relationship between ambulance response times and the odds of surviving a MVC, especially in rural settings where ambulance response times tend to be longer.

To explore the effect of the ACA on ambulance response times, we begin by estimating a DD equation of the following form:

$$(3)\quad Response\ Time_{acst} = \alpha_0 + \alpha_1 Post_t + \alpha_2\,(Post_t \text{ x } Medicaid\ Expansion_s) + \boldsymbol{\alpha}'_3 \boldsymbol{X}_{acst} + \theta_c + \varepsilon_{acst},$$

where the dependent variable is the time (in minutes) that elapsed between when the EMS provider was notified and when the ambulance first arrived on the scene of fatal accident *a*, in

[19] Gonzalez et al. (2009, p. 34) concluded that "protracted scene times" in rural, but not urban, areas may "contribute to increased mortality."

county c, state s, and year t.[20] Because the unit of observation is now the fatal accident, we are able to add a vector of accident-specific controls. This vector, $\boldsymbol{X}_{acst}$, includes indicators for weather conditions at the time of the accident, an indicator for whether the accident occurred at night, and an indicator for whether the accident occurred on a weekend.[21]

Estimates of equation (3) are reported in the first column of Table 3. Full implementation of the ACA is associated with an increase in ambulance response times of 0.28 minutes, or approximately 17 seconds, which is arguably too small to warrant the attention of policymakers. However, a DD estimation strategy is, obviously, far from ideal (Courtemanche et al., 2017a, p. 186). In an effort to account for national- and state-level shocks to response times, we estimate a DDD-style regression of the form:

(4) $Response\ Time_{acst} = \beta_0 + \beta_1(Post_t \text{ x } Uninsured2013_c) + \beta_2(Post_t \text{ x } Uninsured2013_c \text{ x } Medicaid\ Expansion_s) + \boldsymbol{\beta}_3'\boldsymbol{X}_{acst} + \theta_c + \gamma_{st} + \varepsilon_{acst}$,

Estimates of β_1 and β_2, which are reported in the remaining columns of Table 3, can be thought of as causal under the assumption that county-level uninsured rates in 2013 would have been uncorrelated with the change in ambulance response times had the ACA not been implemented. Our focus is on the estimated effect of the full ACA, which is calculated, as earlier, at the mean of the pre-ACA uninsured rates, $\overline{Uninsured2013_c}$. Specifically, the effect of the ACA in non-

[20] The response time is top-coded at 180 minutes, but the results discussed below are robust to the including the 15 accidents with response times above this threshold.

[21] The weather conditions indicators are for rain, sleet, snow, fog, wind, blowing dirt, cloud cover, blowing snow, freezing rain, and other hazardous conditions. Means and standard deviations of all the variables used in the accident-level regressions are shown in Appendix Table A2.

expansion states is given by β_1 x $\overline{Uninsured2013_c}$, while the effect of the ACA in expansion states is given by (β_1 + β_2) $\overline{Uninsured2013_c}$.

Without controlling for the variables in the vector $\boldsymbol{X}_{acst}$, full implementation of the ACA is associated with an increase in ambulance response times of 1.8 minutes (i.e., one minute and 48 seconds), which represents an almost 18 percent increase relative to the mean of 10.08. Controlling for the variables in the vector $\boldsymbol{X}_{acst}$, full implementation of the ACA is associated with an increase in ambulance response times of 1.89 minutes, or almost 19 percent relative to the mean.

3.1. Adopting response-time cutoffs from the medical literature

Medical researchers interested in the determinants of trauma survival have often focused on whether EMS workers arrived within a specified period of time. For instance, Pons et al. (2005) found that the odds of survival were reduced by 30% if an ambulance failed to arrive on scene within 4 minutes.[22] By contrast, these authors found that failure to arrive within 8 minutes was not associated with the odds of survival (Pons et al., 2005).[23] The National Fire Protection Association (NFPA), which publishes guidelines for the operation of all emergency services, recommends a 4 minute response time for basic life support and an 8 minute response time for advanced life support (NFPA 2010).

[22] See also Blackwell and Kaufman (2002), who found that the risk of patient death increased threefold if EMS workers failed to arrive on scene within 5 minutes of receiving an emergency call. Newgard et al. (2010) examined whether the time elapsed from when EMS workers arrived on scene and when the patient was admitted to the hospital. These authors concluded that reducing this time had no effect on the odds of patient survival.

[23] The 8-minute cutoff was chosen by Pons et al. (2005) because it is “commonly accepted” that EMS personnel should arrive on scene within 8 minutes of notification (Shah, 2006, p. 420). In fact, many EMS contracts stipulate response times of less than 8 minutes for 90% of emergency calls (Pons and Markovchick, 2002).

In Table 4, we re-estimate equation (4), replacing *Response Time*, which is measured in minutes, with an indicator for whether the ambulance failed to arrive within a particular window. Specifically, we consider 4 cutoffs: failure to arrive within 4 minutes, 8 minutes, 13 minutes, and 20 minutes. The 4-minute cutoff is based on Pons et al. (2005) and has been used by other medical researchers (Eisenberg et al., 1984; Callaham and Madsen, 1996). The 8-minute cutoff can be thought of as the EMS industry standard (Pons and Markovchick, 2002; Shah, 2006; NFPA, 2010) and corresponds to the median ambulance response time observed in FARS. The 13- and 20-minute cutoffs correspond to the 75th and 90th pre-ACA percentiles of ambulance response times in the FARS data.

The results suggest that implementation of the ACA had little impact on whether ambulances arrived within 4 minutes, the cutoff proposed by Pons et al. (2005). Not only are the estimated coefficients reported in column (1) of Table 4 statistically insignificant, they are also extremely small relative to the mean of the dependent variable. 0.79. By contrast, there is strong evidence that the ACA resulted in fewer ambulances arriving within 8 minutes, the EMS industry standard: at the mean of the pre-ACA uninsured rate, full implementation is associated with an increase of 0.096 in the probability of not arriving within 8 minutes, a 21% increase relative to the mean of 0.45. Full implementation is also associated with an increase of 0.093 in the probability of not arriving within 13 minutes, a 43% increase relative to the mean (0.093/0.216 = 0.431). The estimated effect of full implementation on the probability of not arriving within 20 minutes is 0.049, which represents an almost 60% increase relative to the mean (0.049/0.084 = 0.583).

3.2. The effects of the ACA on other outcomes

Up to this point in the analysis, we have focused on ambulance response times, but FARS also contains information on hospital arrival times. In the first column of Table 5, we report estimates of equation (4) in which response time is replaced with the time (in minutes) that elapsed between when the ambulance arrived at the scene of the accident and when it arrived at the hospital. If the closest emergency department is too congested, ambulances are routinely diverted to less busy, but more distant, emergency departments (Schull et al., 2003). Therefore, implementation of the ACA could have affected this alternative outcome through emergency room congestion (Schull et al., 2003; Wilper et al., 2008; Garthwaite et al., 2017). Full implementation is, in fact, associated with an increase in time to hospital of 1.27 minutes. However, this estimate is not significant at conventional levels. Moreover, it is quite modest in terms of magnitude, representing a 3% increase relative to the mean (1.27/42.86 = 0.030).

Next, we explore whether the ACA affected fatal accident totals in FARS. If ambulances were indeed slower to arrive on scene, this could have reduced the likelihood of survival (Durkin et al., 2005; Zwerling et al., 2005; Li et al. 2008; Gonzalez et al., 2009; Sánchez-Mangas, 2010) and, as a consequence, increased the total number of fatal accidents observed in FARS, which represents a complete census of all fatal MVCs.[24] To conduct this analysis, we collapsed the FARS data into county-year cells and estimated equation (4) using the total number of fatalities in county c and year t as the outcome. The results are reported in the second column of Table 5. Full implementation of the ACA is associated with 5.17 additional fatal accidents per county-year. Although sizeable (the mean number of fatalities per county-year was 6.13), because this

[24] Recall that FARS does not include information on non-fatal accidents. If an injured driver or passenger survived because an ambulance arrived quickly, then information on the accident that produced the injury would not be included in FARS. Below, we show that the implementation of the ACA did not affect accident observables in the FARS data, suggesting any shift the underlying accident-generating process was negligible.

estimate is not statistically significant we cannot rule out the possibility that the ACA had no effect on the total number of fatal accidents. Likewise, implementation of the ACA is associated with 5.38 additional fatalities resulting from MVCs, but again this estimate is not statistically significant at conventional levels.

Finally, we used data from the *County Business Patterns*, published by the Census Bureau, to construct two additional outcomes: (1) the number of workers who provided ambulance services in county *c* and year *t*, and (2) the average salary of these workers in county *c* and year *t*.[25] Estimates of equation (4) using these alternative outcomes are reported in the remaining columns of Table 5. These estimates provide little evidence that the ACA led to changes in the supply of EMS services, at least in the short run.

3.3. Specification checks

In this section, we present results from a variety of regressions with the goal of ruling out potential endogeneity concerns. As a test of the parallel trends assumption, we estimate an event-study model that interacts treatment (i.e., *Uninsured* and *Uninsured x Medicaid Expansion*) with the full set of year fixed effects (omitting 2013 as the base year). If the identifying assumptions of the DDD model hold, the estimated coefficients of these interactions should be statistically indistinguishable from zero. In the top panel of Table 6, we report the event-study results for the ambulance response outcomes using the full set of controls. The effect of full implementation in the post-ACA period is, as before, given the in the bottom panel of Table 6. There are 24 falsification tests (6 parameters of interest in each of 4 regressions), but only one significant estimate at the 5% level. This is less than would be expected by chance and

[25] Specifically, we constructed employee counts and average annual salary (total annual payroll divided by employees) using the NAICS code 621910 (ambulance services). Counties had to have at least three establishments that provided ambulance services.

provides assurance that the estimates in the bottom panel of Table 6 can be thought of representing the causal effects of ACA.

Next, because traffic congestion can have a powerful effect on ambulance response times (Peters and Hall, 1999; Lee and Fazio, 2005; Ghosh et al., 2014), it also represents a potential threat to our preferred identification strategy. If, for instance, the 2013 uninsured rate were positively correlated with the change in congestion from 2013 to the post-ACA period, this could impart an upwards bias to our estimates of the relationship between the ACA and ambulance response times. To address this potential source of bias, we utilized information from the "Urban Mobility Scorecard", produced by the Texas A&M Transportation Institute. Specifically, we included two new controls on the right-hand side of equation (4), both of which are available on an annual basis for 101 metropolitan areas in the United States: the first, *Hours Lost to Traffic*, is equal to the average time spent by commuters waiting in traffic per year; the second, the *Time Index*, is calculated as the ratio of peak-period travel time to free-flow travel time faced by commuters.

The results of this exercise, reported in Table 7, provide no evidence that the interactions *Post* x *Uninsured* and *Post* x *Uninsured* x *Medicaid Expansion* are somehow capturing the influence of traffic congestion. In column (1) of Table 7, we show the effect of the ACA on ambulance response times in counties that belong to the 101 U.S. metropolitan areas for which we have information on traffic congestion. Full implementation is associated with an increase in response times of 3.31 minutes, an estimate which is considerably larger than the estimated first reported in Table 3. This result provides additional evidence that the effect of the ACA on ambulance response times was more pronounced in more populous, urban counties. In the second and third columns of Table 7, we control for traffic congestion by including *Hours Lost* *to Traffic* and the *Time Index* on the right-hand side of equation (4). The resulting estimates of the effect of full implementation are statistically significant and are of comparable magnitude to the estimate in the first column of Table 7, suggesting that the relationship between pre-ACA uninsured rates and ambulance response times is not simply a reflection of worsening traffic.[26]

In Table 8, we explore the sensitivity of our estimates to controlling for local economic conditions, an important driver of pre-ACA uninsured rates. Specifically, we report estimates of equation (4) with median household income, the poverty rate and the unemployment rate in the vector $\boldsymbol{X}_{acst}$. These measures were obtained from published sources and are at the county-year level.[27] The results suggest that the relationship between pre-ACA uninsured rates and ambulance response times is not a reflection of local economic conditions.

Up to this point, we have excluded counties with a population of less than 10,000 from our analyses in an effort to ensure that the pre-ACA uninsured rate estimates were sufficiently precise. In Appendix Table A6, we explore whether our results are robust to removing this exclusion. In addition, we experiment with excluding counties with population less than 20,000 as well as excluding counties with a population of less than 30,000. The estimated effect of the ACA on ambulance response times is positive and significant across these different samples, but

[26] In Appendix Table A3, we test if the relationship between the ACA and whether an ambulance arrived within 8 minutes is sensitive to controlling for these same traffic congestion measures. In Appendix Tables A4 and A5, we report estimates of equation (4) controlling for 4 proxies of traffic congestion at the county-year level: employment in "support activities for road transportation" (NAICS code 4884), average concentration of carbon monoxide (CO), average concentration of nitrogen dioxide (NO2), and a measure of fine particulate pollution. Information on NAICS code 4884 employment was obtained from *County Business Patterns*, published by the Census Bureau. Information on pollution levels was obtained from the Air Quality System database, collected by the Environmental Protection Agency. We focused on these pollutants because nationally 50% of carbon monoxide emissions are caused by motor vehicles, 34% of nitrogen dioxide emissions are caused by motor vehicles, and 11% of fine particulate matter (PM 2.5) is caused by motor vehicle emissions (Ernst, Corless and Greene-Roesel 2003). The results provide no evidence that the relationship between pre-ACA uninsured rates and ambulance response times is not a reflection of worsening traffic.

[27] Data on median household income, the poverty rate, and population are from SAIPE (Small Area Income and Poverty Estimates), produced by the U.S. Census Bureau. County-by-year estimates of the local unemployment rate are from LAUS (Local Area Unemployment Statistics), produced by the Bureau of Labor Statistics.

becomes larger as we focus on more populous counties.[28] Our baseline sample selection criteria can therefore be considered conservative.[29]

In a final set of specification checks, we examined whether the implementation of the ACA was associated with changes in accident observables. Specifically, we regressed the personal characteristics of people killed in MVCs (i.e., race, gender, age) on *Post* x *Uninsured*, *Post* x *Uninsured* x *Medicaid Expansion*, a set of county indicators, and year-by-state indicators. In addition, we regressed measures of accident victims' behavior (e.g., an indicator for whether the victim was wearing a seat belt, and an indicator for whether the driver's Blood Alcohol Content was over the legal limit) and other MVC observables on these same right-hand-side variables. Because a MVC must produce at least one fatality to be included in FARS, any association between the implementation of the ACA and accident victim characteristics could reflect a shift in the underlying accident-generating process. For instance, although not statistically significant, the estimates reported earlier in Table 5 raise the possibility that full implementation of the ACA led to substantially more traffic fatalities and fatal MVCs. Econometrically, it is not obvious that this phenomenon, in and of itself, would bias our estimates, but changes in accident observables could potentially explain the post-ACA increase in ambulance response times. The results of this exercise are reported in Appendix Tables A8-

[28] For instance, when we exclude counties with a population of less than 30,000 from the analysis, full implementation is associated with an increase in ambulance response times of 2.74 minutes, which is almost 45% larger than our original estimate reported in Table 3.

[29] Table A7 reports the results from additional robustness checks. Twenty states and the District of Columbia partially expanded Medicaid under the ACA prior to 2014. Following Kaestner et al. (2015), we experimented with excluding states from the analysis that partially expanded Medicaid under the ACA prior to 2014 but did not fully expand on January 1, 2014 (IN, ME, TN, WI, DE, DC, MA, NY and VT). We also experimented with excluding states from the analysis that partially expanded Medicaid under the ACA and fully expanded on January 1, 2014 (AZ, CA, CT, CO, HI, IL, IA, MD, MN, NJ, OR, RI and WA). The results are qualitatively similar to those reported in Table 3. Finally, we re-estimated the relationship between the ACA and response times using the average uninsured rate from 2011-2013 instead of the 2013 uninsured rate. Again, the results are qualitatively similar to those reported in Table 3.

A9. Although we ran 17 separate regressions, only one produced a statistically significant estimate of full implementation. The other estimates of full implementation were, without exception, small and statistically insignificant. This pattern of results is consistent with the hypothesis that the observed increase in ambulance response time is due to the ACA rather than other factors, including endogenous selection into the sample, correlated with the intensity of treatment.

4. CONCLUSION

A substantial literature examines the potential benefits of health insurance expansions on access to medical care and various health outcomes, but relatively few studies have explored a potential pitfall: the inability of providers of health care services to keep up with demand, causing capacity shortfalls, at least in the short term. We help fill this void by leveraging variation in county pre-treatment uninsured rates and state Medicaid expansions to explore whether implementation of the ACA led to an increase in ambulance response times.

Our estimates suggest that, after two years, full implementation of the ACA led to an increase in insurance coverage of approximately 5 percentage points and an increase in ambulance response time of 1.89 minutes (or one minute and 53 seconds). Together, these estimates suggest that every percentage point increase in insurance enrollment in a given county due to the ACA slowed down ambulances in that county by approximately 22.8 seconds, which implies a short run elasticity of ambulance response time with respect to insurance enrollment of 3.2.

In addition to examining the effect of the ACA on response times in minutes, we considered two cutoffs from the medical literature: failure to arrive within 4 minutes, and failure to arrive within 8 minutes. Our results suggest that every percentage point increase in insurance enrollment led to an almost 0.02 percentage point increase in the probability of an ambulance arriving after 8 minutes, the industry-recommended response time. However, we found no evidence that the ACA affected the probability of responding after 4 minutes, which Pons et al. (2005) suggest may be more relevant for MVC patient outcomes than the 8-minute cutoff.

While the nature of the FARS data required that we focus on MVCs, our results likely have implications for non-MVC emergencies as well. Cardiac arrest survival is particularly sensitive to ambulance response times, (Pell et al., 2001; Vukmir, 2006; O'Keeffe et al., 2011), with the most recent study finding that a one-minute reduction in response time was associated with a 24 percent improvement in survival odds. There is additional research showing that when distance travelled is used as an instrument for response time, a one-minute increase in response time increases mortality risk for all emergencies by 8 to 17 percent (Wilde 2012). Therefore, if the response times in the FARS are representative of all ambulances, then the estimated ambulance slowdowns may have had a profound impact on patient outcomes for non-MVC emergencies.

We present suggestive evidence supporting the external validity of our estimates in Table 9. Table 9 reports average ambulance response times for all ambulances based on public reports put out by several cities and by the state of Florida. Alongside those averages, Table 9 reports the average response time for the corresponding location based on the FARS. The averages are quite similar, making the argument that our results generalize to all ambulances and not just those responding to fatal MVCs plausible. If this is the case, then the short run ambulance slowdowns due to the ACA were likely quite costly in terms of patient outcomes given the large magnitudes found for the effect of response time on patient outcomes for events such as cardiac arrest (Pell et al., 2001; Vukmir, 2006; O'Keeffe et al., 2011).

Finally, note that we provide only one piece of a much larger puzzle with regard to evaluating the costs and benefits of the ACA. Even if the ACA increased wait times for various medical services, the resulting welfare losses should be evaluated alongside other factors such as the costs of the Medicaid expansion and subsidies and the welfare gains from risk protection and, potentially, improved health. Moreover, it is possible that the increase in wait times could prove to be transitory, as adjusting the quantity of medical services provided may be more feasible in the long run than the short run. Nonetheless, our research provides a novel addition to the body of evidence on provider shortages and their implications for policy.

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Table 1. The ACA and Proportion Insured

	(1)	(2)
Post	0.043***	
	(0.003)	
Post x Medicaid expansion	0.013***	
	(0.008)	
Post x Uninsured		0.165***
		(0.051)
Post x Uninsured x Medicaid expansion		0.115*
		(0.062)
Implied effects at mean pre-treatment uninsured rate:		
ACA w/o Medicaid expansion	0.043***	0.030***
	(0.003)	(0.009)
Medicaid expansion	0.013***	0.021*
	(0.008)	(0.011)
Full ACA (with Medicaid expansion)	0.057***	0.050***
	(.007)	(0.006)
County fixed effects	yes	yes
State-by-year fixed effects	no	yes
Observations	14,663	14,663
Mean of dependent variable	0.842	0.842

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from county-year level regressions are shown. Data on insurance coverage rates are from the Small Area Health Insurance Estimates (SAHIE) program and cover the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Estimates weighted by county population from the 2010 Census. Counties with population of less than 10,000 are excluded from the analysis.

Table 2. The ACA and Insurance Coverage: Separating *Post* into 2014 and 2015

	Proportion Insured
2014 x Uninsured	0.126**
	(0.050)
2014 x Uninsured x Medicaid expansion	0.080
	(0.058)
2015 x Uninsured	0.204***
	(0.052)
2015 x Uninsured x Medicaid expansion	0.150**
	(0.066)
Implied effects at mean pre-treatment uninsured rate:	
ACA w/o Medicaid expansion, 2014	0.023**
	(0.009)
Medicaid expansion, 2014	0.014
	(0.010)
Full ACA (with Medicaid expansion), 2014	0.037***
	(0.005)
ACA w/o Medicaid expansion, 2015	0.037***
	(0.009)
Medicaid expansion, 2015	0.027**
	(0.012)
Full ACA (with Medicaid expansion), 2015	0.063***
	(0.007)
County fixed effects	yes
State-by-year fixed effects	yes
Observations	14,663
Mean of dependent variable	0.842

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from a county-year level regression are shown. Data on insurance coverage rates are from the Small Area Health Insurance Estimates (SAHIE) program and cover the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Estimates weighted by county population from the 2010 Census. Counties with population of less than 10,000 are excluded from the analysis.

Table 3. The ACA and Ambulance Response Times in Minutes

	(1)	(2)	(3)
Post	-0.03		
	(0.33)		
Post x Medicaid expansion	0.32		
	(0.34)		
Post x Uninsured		6.09***	5.87**
		(2.43)	(2.34)
Post x Uninsured x Medicaid expansion		4.26	4.95
		(4.30)	(4.00)
Implied effects at mean pre-treatment uninsured rate:			
ACA w/o Medicaid expansion	-0.03	1.06**	1.02**
	(0.33)	(0.75)	(0.41)
Medicaid expansion	0.32	0.76	0.86
	(0.34)	(0.75)	(0.70)
Full ACA (with Medicaid expansion)	0.28**	1.80**	1.89**
	(0.13)	(0.69)	(0.65)
Weather indicators	yes		yes
Night and weekend indicators	yes		yes
County fixed effects	yes	yes	yes
State-by-year fixed effects	no	yes	yes
Observations	84,185	84,185	84,185
Mean of dependent variable	10.08	10.08	10.08

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data on are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Table 4. The ACA and Ambulance Response Time Cutoffs

	> 4 minutes	> 8 minutes	> 13 minutes	> 20 minutes
Post x Uninsured	-0.006	0.232	0.265*	0.178***
	(0.148)	(0.144)	(0.149)	(0.063)
Post x Uninsured x Medicaid expansion	0.029	0.322	0.270	0.104
	(0.281)	(0.230)	(0.214)	(0.095)
Implied effects at mean pre-treatment uninsured rate:				
ACA w/o Medicaid expansion	-0.001	0.040	0.046*	0.031***
	(0.026)	(0.025)	(0.026)	(0.011)
Medicaid expansion	0.005	0.056	0.047	0.018
	(0.049)	(0.040)	(0.037)	(0.017)
Full ACA (with Medicaid expansion)	0.004	0.096***	0.093***	0.049***
	(0.041)	(0.030)	(0.032)	(0.018)
Weather indicators	yes	yes	yes	yes
Night and weekend indicators	yes	yes	yes	yes
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	84,185	84,185	84,185	84,185
Mean of dependent variable	0.794	0.450	0.216	0.084

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Table 5. The ACA and Other Outcomes

	Time Accident to Hospital	Number of Fatal Accidents	Number of Fatalities	Employees in Ambulance Services	Average Annual Salary in Ambulance Services (Thousands)
Post x Uninsured	-8.36	-3.59	4.24	-423.65	-32.75
	(12.81)	(48.00)	(55.05)	(409.49)	(29.21)
	15.66	33.26	26.64	118.76	29.50
	(27.52)	(52.47)	(59.33)	(1818.64)	(33.64)
Implied effects at mean pre-treatment uninsured rate:					
	-1.46	-0.63	0.74	-64.65	-5.00
	(2.23)	(8.37)	(9.60)	(62.49)	(4.46)
Medicaid	2.73	5.80	4.65	18.12	4.50
	(4.80)	(9.15)	(10.35)	(277.52)	(5.13)
	1.27	5.17	5.38	-46.53	-0.50
	(4.41)	(3.70)	(3.86)	(270.49)	(2.55)
Weather indicators	yes	no	no	no	no
Night and weekend indicators	yes	no	no	no	no
County fixed effects	yes	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes	yes
Observations	20,343	13,356	13,356	1,769	1,769
Mean of dependent variable	42.86	6.13	6.71	294.60	30.73

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: In the first column, we report OLS estimates from an accident-level regression. The regressions in the remaining columns are at the county-year level and are weighted by county population from the 2010 Census. Data are from the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Table 6. The ACA and Insurance Coverage: Event-Study Analysis

	Minutes	8 minutes	13 minutes	20 minutes
2010 x Uninsured	-2.098	0.408	0.069	-0.044
	(5.864)	(0.268)	(0.244)	(0.150)
2010 x Uninsured x Medicaid expansion	5.312	-0.027	0.290	0.084
	(8.055)	(0.413)	(0.365)	(0.195)
2011 x Uninsured	-5.391	0.060	-0.205	-0.112
	(4.431)	(0.214)	(0.211)	(0.163)
2011 x Uninsured x Medicaid expansion	2.670	-0.021	0.122	-0.013
	(6.896)	(0.353)	(0.287)	(0.218)
2012 x Uninsured	-3.363	0.420**	0.105	-0.233
	(4.243)	(0.196)	(0.228)	(0.172)
2012 x Uninsured x Medicaid expansion	2.395	-0.041	-0.044	0.260
	(6.367)	(0.302)	(0.285)	(0.208)
Post x Uninsured	3.773	0.451**	0.280	0.100
	(3.113)	(0.185)	(0.186)	(0.093)
Post x Uninsured x Medicaid expansion	6.217	0.303	0.309	0.148
	(4.463)	(0.272)	(0.250)	(0.094)
Implied effects at mean pre-treatment uninsured rate:				
ACA w/o Medicaid expansion	0.655	0.078**	0.049	0.017
	(0.540)	(0.032)	(0.032)	(0.016)
Medicaid expansion	1.079	0.053	0.054	0.026
	(0.774)	(0.047)	(0.043)	(0.016)
Full ACA (with Medicaid expansion)	1.733**	0.130***	0.102**	0.043**
	(0.797)	(0.033)	(0.042)	(0.017)
Weather indicators	yes	yes	yes	yes
Night and weekend indicators	yes	yes	yes	yes
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	84,185	84,185	84,185	84,185
Mean of dependent variable	10.08	0.450	0.216	0.084

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Table 7. The ACA and Ambulance Response Times in 101 Metropolitan Areas: Adding Controls for Traffic Congestion

	(1)	(2)	(3)
Post x Uninsured	4.08	3.67	4.82
	(7.96)	(8.08)	(7.83)
Post x Uninsured x Medicaid expansion	16.66***	16.83**	16.38**
	(7.25)	(7.24)	(7.16)
Hours Lost to Traffic		-0.04	
		(0.17)	
Travel Time Index			18.00
			(30.38)
Implied effects at mean pre-treatment uninsured rate:			
ACA w/o Medicaid expansion	0.65	0.59	0.77
	(1.27)	(1.29)	(1.25)
Medicaid expansion	2.66**	2.69**	2.61**
	(1.57)	(1.55)	(1.14)
Full ACA (with Medicaid expansion)	3.31***	3.27**	3.38***
	(0.13)	(0.66)	(0.68)
Weather indicators	yes	yes	yes
Night and weekend indicators	yes	yes	yes
County fixed effects	yes	yes	yes
State-by-year fixed effects	yes	yes	yes
Observations	14,279	14,279	14,279
Mean of dependent variable	8.53	8.53	8.53

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data on are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Sample restricted to accidents that occurred in the 101 metropolitan areas for which traffic congestion data were available. See Schrank et al. (2015) for more information on these areas and how the traffic congestion variables were constructed.

Table 8. The ACA and Ambulance Response Times: Adding Local Economic Controls

	(1)	(2)	(3)
Post x Uninsured	5.87**	5.84**	6.75***
	(2.34)	(2.28)	(2.32)
Post x Uninsured x Medicaid expansion	4.95	4.77	4.90
	(4.00)	(3.98)	(3.97)
Median Household Income (thousands)		-0.011	-0.012
		(0.021)	(0.021)
Poverty Rate		0.589	0.056
		(3.95)	(4.00)
Population (millions)		-0.153	-0.159
		(0.207)	(0.209)
Unemployment Rate			0.178*
			(0.102)
Implied effects at mean pre-treatment uninsured rate:			
ACA w/o Medicaid expansion	1.02**	1.02**	1.18***
	(0.41)	(0.40)	(0.41)
Medicaid expansion	0.86	0.83	0.85
	(0.70)	(0.69)	(0.69)
Full ACA (with Medicaid expansion)	1.89**	1.85***	2.03***
	(0.65)	(0.66)	(0.67)
Weather indicators	yes	yes	yes
Night and weekend indicators	yes	yes	yes
County fixed effects	yes	yes	yes
State-by-year fixed effects	yes	yes	yes
Observations	84,185	84,184	84,184
Mean of dependent variable	10.08	10.08	10.08

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data on are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Table 9. Comparison of FARS Response Times to All Response Times

		Average Ambulance Response Time For	
Locality	Year	Fatal Accidents (FARS)	All Ambulances
Manhattan, NY	2010	4:51	4:21
Washington D.C.	2014	6:52	6:18
Oklahoma City, OK	2010	7:04	7:06
Milwaukee, WI	2010	5:06	5:14
Florida	2013	8:53	10:40

Notes: Response times for localities are drawn from: NYC OpenData (2017b), D.C. Fire and Emergency Medical Services Department (2017), Lansdale (2011), City of Milwaukee Fire Department (2011) and Florida Department of Health (2015).

Appendix Tables

Appendix Table A1. Did the Implementation of the ACA Affect Whether Ambulance Response Time was Missing in FARS?

	Missing response time
Post x Uninsured	-0.0008
	(0.0015)
Post x Uninsured x Medicaid expansion	-0.0022
	(0.0032)
Implied effects at mean pre-treatment uninsured rate:	
ACA w/o Medicaid expansion	-0.015
	(0.026)
Medicaid Alone	-0.039
	(0.056)
Full ACA (with Medicaid expansion)	-0.054
	(0.050)
Weather	yes
Weekday/Weekend	yes
County fixed effects	yes
State-by-year fixed effects	yes
Observations	183,532
R-squared	0.52
Mean Outcome	.448

Notes: OLS estimates from an accident-level regression of an indicator for missing response time on *Post* x *Uninsured*, *Post* x *Uninsured* x *Medicaid Expansion*, a set of accident-level controls, county fixed effects, and state-by-year fixed effects are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Estimates weighted by county population from the 2010 Census. Counties with a population of less than 10,000 are excluded from the analysis. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table A2. Descriptive Statistics

	Full Sample	Medicaid Expansion States	Non-Expansion States	Before ACA	After ACA
Ambulance Timing					
Time to Accident	10.082	9.603	10.711	10.004	10.253
	(8.741)	(8.861)	(8.540)	(8.425)	(9.397)
Slower than 4 minutes	0.973	0.765	0.831	0.791	0.800
	(0.405)	(0.424)	(0.375)	(0.407)	(0.400)
Slower than 8 minutes	0.450	0.419	0.491	0.447	0.455
	(0.497)	(0.493)	(0.500)	(0.497)	(0.498)
Slower than 13 minutes	0.216	0.194	0.244	0.215	0.217
	(0.411)	(0.396)	(0.429)	(0.411)	(0.412)
Slower than 20 minutes	0.084	0.073	0.099	0.084	0.085
	(0.278)	(0.261)	(0.298)	(0.277)	(0.280)
Time to Hospital	42.861	42.750	42.968	42.673	43.609
	(24.058)	(24.058)	(22.163)	(23.843)	(24.885)
Weather Conditions					
Rain	0.070	0.072	0.068	0.067	0.073
	(0.255)	(0.259)	(0.251)	(0.253)	(0.261)
Sleet	0.004	0.004	0.004	0.004	0.004
	(0.064)	(0.064)	(0.063)	(0.063)	(0.066)
Snow	0.017	0.023	0.009	0.018	0.015
	(0.128)	(0.149)	(0.094)	(0.131)	(0.121)
Fog	0.011	0.011	0.010	0.011	0.010
	(0.102)	(0.104)	(0.101)	(0.104)	(0.098)
Cloudy	0.165	0.162	0.168	0.163	0.169
	(0.371)	(0.368)	(0.374)	(0.369)	(0.374)
Blowing Snow	0.001	0.002	0.001	0.001	0.001
	(0.037)	(0.042)	(0.028)	(0.038)	(0.035)
Freezing Rain	0.000	0.001	0.000	0.000	0.001
	(0.022)	(0.022)	(0.020)	(0.012)	(0.034)
Wind	0.002	0.002	0.002	0.002	0.001
	(0.040)	(0.041)	(0.040)	(0.042)	(0.036)
Blowing Dirt	0.000	0.000	0.000	0.000	0.000
	(0.019)	(0.020)	(0.017)	(0.042)	(0.019)
Other Inclement Weather	0.000	0.002	0.001	0.001	0.002
	(0.019)	(0.020)	(0.034)	(0.035)	(0.041)
Time of Accident					
Nighttime Accident	0.483	0.483	0.483	0.484	0.482
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
Weekend Accident	0.340	0.337	0.342	0.342	0.333
	(0.474)	(0.473)	(0.474)	(0.474)	(0.471)
Observations	84,240	47,817	36,423	57,945	26,295

Notes: counties with less than 10,000 population are excluded from the analysis. Means (and standard deviations) shown.

Appendix Table A3. The ACA and Likelihood of Ambulance Arriving > than 8 Minutes in 101 Metropolitan Areas: Adding Controls for Traffic Congestion

	(1)	(2)	(3)
Post x Uninsured	1.001	1.024	1.006
	(0.747)	(0.732)	(0.734)
Post x Uninsured x Medicaid expansion	0.700	0.690	0.698
	(0.762)	(0.749)	(0.759)
Hours Lost to Traffic		0.002	
		(0.008)	
Travel Time Index			0.137
			(1.314)
Implied effects at mean pre-treatment uninsured rate:			
ACA w/o Medicaid expansion	0.160	0.163	0.161
	(0.119)	(0.117)	(0.117)
Medicaid expansion	0.112	0.110	0.111
	(0.122)	(0.120)	(0.121)
Full ACA (with Medicaid expansion)	0.271***	0.273***	0.272***
	(0.089)	(0.89)	(0.088)
Weather indicators	yes	yes	yes
Night and weekend indicators	yes	yes	yes
County fixed effects	yes	yes	yes
State-by-year fixed effects	yes	yes	yes
Observations	14,279	14,279	14,279
Mean of dependent variable	0.348	0.348	0.348

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data on are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Counties with a population of less than 10,000 are excluded from the analysis. Standard errors, corrected for clustering at the state level, are in parentheses. Sample restricted to accidents that occurred in the 101 metropolitan areas for which traffic congestion data were available. See Schrank et al. (2015) for more information on these areas and how the traffic congestion variables were constructed.

Table A4. The ACA and Ambulance Response Times Controlling for Employment in NAICS Code 4884 (Support Activities for Road Transportation)

	(1)	(2)
Post x Uninsured	9.452	10.650*
	(5.805)	(5.589)
Post x Uninsured x Medicaid expansion	1.684	1.304
	(7.077)	(6.906)
Employment in NAICS code 4884		0.004**
		(0.002)
Implied effects at mean pre-treatment uninsured rate:		
ACA w/o Medicaid expansion	1.476	1.664*
	(0.907)	(0.873)
Medicaid expansion	0.263	0.204
	(1.105)	(1.079)
Full ACA (with Medicaid expansion)	1.740	1.867
	(1.209)	(1.193)
Weather indicators	yes	yes
Night and weekend indicators	yes	yes
County fixed effects	yes	yes
State-by-year fixed effects	yes	yes
Observations	22,884	22,884
Mean of dependent variable	8.616	8.616

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from an accident-level regression of ambulance response times (in minutes) on *Post* x *Uninsured*, *Post* x *Uninsured* x *Medicaid Expansion*, a set of accident-level controls, county fixed effects, and state-by-year fixed effects are shown. Standard errors, corrected for clustering at the state level, are in parentheses. Estimates weighted by county population from the 2010 Census. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis. Employment data are from the U.S. Census County Business Patterns and are only populated for counties with at least 3 employers.

Table A5. The ACA and Ambulance Response Times with Controls for Traffic-Related Pollutants

	(1)	(2)	(3)	(4)	(5)	(6)
Post x Uninsured	21.893*	20.888*	7.778	7.320	10.058*	10.270*
	(11.283)	(11.638)	(8.432)	(8.902)	(5.382)	(5.416)
	0.428	1.415	16.853**	16.611**	7.576	7.548
	(11.176)	(11.456)	(7.829)	(7.963)	(6.287)	(6.279)
		-2.278				
		(1.565)				
				-0.115		
				(0.095)		
						-0.114
						(0.069)
<u>*Implied effects at mean pre-treatment uninsured rate*</u>:						
	3.439*	3.281*	1.252	1.179	1.579*	1.612*
	(1.773)	(1.828)	(1.358)	(1.433)	(0.845)	(0.850)
Medicaid expansion	0.067	0.222	2.713**	2.674**	1.190	1.185
	(1.756)	(1.780)	(1.261)	(1.282)	(0.987)	(0.986)
	3.507***	3.504***	3.967***	3.853***	2.769***	2.797***
	(1.064)	(1.100)	(0.775)	(0.783)	(0.787)	(0.783)
Weather indicators	yes	yes	yes	yes	yes	yes
Night and weekend indicators	yes	yes	yes	yes	yes	yes
County fixed effects	yes	yes	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes	yes	yes
Observations	10,047	10,047	11,242	11,242	23,367	23,367
Mean of dependent variable	7.764	7.764	8.482	8.482	8.734	8.734

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from an accident-level regression of ambulance response times (in minutes) on *Post* x *Uninsured*, *Post* x *Uninsured* x *Medicaid Expansion*, a set of accident-level controls, county fixed effects, and state-by-year fixed effects are shown. Data on are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis. Pollution data are from the Environmental Protection Agency's Air Quality System Database.

Appendix Table A6. The ACA and Ambulance Response Times: Alternative Samples

	All U.S. counties	Counties with population < 10k excluded	Counties with population < 20k excluded	Counties with population < 30k excluded
Post x Uninsured	5.94**	5.87**	6.23**	9.04**
	(2.32)	(2.34)	(2.71)	(3.62)
Post x Uninsured x Medicaid expansion	3.78	4.95	5.31	7.38
	(4.11)	(4.00)	(4.42)	(4.98)
<u>*Implied effects at mean pre-treatment uninsured rate*</u>:				
ACA w/o Medicaid expansion	1.07**	1.02**	1.06**	1.02**
	(0.42)	(0.41)	(0.46)	(0.41)
Medicaid expansion	0.68	0.86	0.90	0.86
	(0.74)	(0.70)	(0.75)	(0.70)
Full ACA (with Medicaid expansion)	1.743**	1.89**	1.96***	2.74***
	(0.73)	(0.65)	(0.70)	(0.74)
Weather indicators	yes	yes	yes	yes
Night and weekend indicators	yes	yes	yes	yes
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	87,823	84,185	78,244	71,689
Mean of dependent variable	10.38	10.08	9.79	9.46

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses.

Appendix Table A7. The ACA and Ambulance Response Times: Measurement Issues

	Use average of 2011-2013 uninsured rate	Exclude "early expanders" that did not fully expand on January 1, 2014	Exclude "early expanders" that fully expanded on January 1, 2014	Exclude all "early expanders"
Post x Uninsured	7.51***	5.23**	5.41**	4.73**
	(2.69)	(2.30)	(2.29)	(2.25)
Post x Uninsured x Medicaid expansion	-0.55	5.71	3.10	7.38
	(4.87)	(4.30)	(3.90)	(4.30)
Implied effects at mean pre-treatment uninsured rate:				
ACA w/o Medicaid expansion	1.30***	0.95**	0.98**	0.90**
	(0.47)	(0.41)	(0.42)	(0.43)
Medicaid expansion	-0.094	1.03	0.563	0.71
	(0.850)	(0.77)	(0.71)	(0.82)
Full ACA (with Medicaid expansion)	1.201*	1.97**	1.55**	1.61*
	(0.699)	(0.74)	(0.67)	(0.80)
Weather indicators	yes	yes	yes	yes
Night and weekend indicators	yes	yes	yes	yes
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	84,185	84,185	78,244	71,689
Mean of dependent variable	10.08	10.29	10.16	10.44

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from accident-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Counties with a population of less than 10,000 are excluded from the analysis. Standard errors, corrected for clustering at the state level, are in parentheses. The "Early Expanders" that expanded their Medicaid programs under the ACA before 2014 but did not fully expand on January 1, 2014, were IN, ME, TN, WI, DE, DC, MA, NY and VT. The "Early Expanders" that fully expanded on January 1, 2014 were AZ, CA, CT, CO, HI, IL, IA, MD, MN, NJ, OR, RI and WA.

Appendix Table A8. The ACA and the Personal Characteristics of Individuals Killed in MVCs.

	Deceased was a White Male	Deceased was a White Female	Deceased was a Black Male	Deceased was a Black Female
Post x Uninsured	-0.062	0.005	0.056	0.005
	(0.086)	(0.097)	(0.038)	(0.032)
Post x Uninsured x Medicaid expansion	-0.062	0.079	0.076	0.046
	(0.215)	(0.158)	(0.058)	(0.062)
Implied effects at mean pre-treatment uninsured rate:				
ACA w/o Medicaid expansion	-0.011	0.001	0.010	0.001
	(0.015)	(0.017)	(0.007)	(0.006)
Medicaid expansion	0.011	0.014	0.014	0.008
	(0.039)	(0.028)	(0.010)	(0.011)
Full ACA (with Medicaid expansion)	0.022	0.015	0.024***	0.009
	(0.035)	(0.022)	(0.008)	(0.009)
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	148,798	148,798	148,798	148,798
Mean of dependent variable	0.582	0.245	0.090	0.035

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from individual-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Appendix Table A8 (continued). The ACA and the Personal Characteristics of Individuals Killed in MVCs

	Deceased was a Hispanic Male	Deceased was a Hispanic Female	Deceased was an Asian Male	Deceased was an Asian Female	Age of Deceased
Post x Uninsured	-0.079	-0.109***	-0.003	0.003	1.87
	(0.156)	(0.028)	(0.009)	(0.010)	(4.71)
Post x Uninsured x Medicaid expansion	0.096	0.159***	-0.009	0.058	3.52
	(0.184)	(0.046)	(0.039)	(0.049)	(7.78)
Implied effects at mean pre-treatment uninsured rate:					
ACA w/o Medicaid expansion	-0.014	-0.020***	-0.001	0.001	0.334
	(0.028)	(0.005)	(0.002)	(0.002)	(0.844)
Medicaid expansion	0.017	0.029***	-0.002	0.010	0.630
	(0.033)	(0.008)	(0.007)	(0.009)	(1.395)
Full ACA (with Medicaid expansion)	0.003	0.009	-0.002	0.011	0.965
	(0.017)	(0.006)	(0.007)	(0.009)	(1.111)
County fixed effects	yes	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes	yes
Observations	165,730	165,730	148,798	148,798	165,618
Mean of dependent variable	0.038	0.015	0.006	0.004	42.47

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from individual-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Appendix Table A9. The ACA and the Circumstances of MVCs

	Died due to Collision with Another Automobile	Died due to Collision with Stationary Object	Police Suspected Individual of Drug Use	Driver of Automobile was Legally Drunk
Post x Uninsured	-0.082	0.008	-0.014	-0.069
	(0.105)	(0.065)	(0.056)	(0.081)
Post x Uninsured x Medicaid expansion	0.053	0.028	-0.044	-0.021
	(0.167)	(0.149)	(0.092)	(0.249)
Implied effects at mean pre-treatment uninsured rate:				
ACA w/o Medicaid expansion	-0.015	0.001	-0.002	-0.012
	(0.019)	(0.012)	(0.010)	(0.014)
Medicaid expansion	-0.009	0.005	-0.008	-0.004
	(0.030)	(0.027)	(0.017)	(0.045)
Full ACA (with Medicaid expansion)	-0.005	0.006	-0.010	-0.016
	(0.023)	(0.024)	(0.013)	(0.042)
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	158,883	158,883	165,775	165,775
Mean of dependent variable	0.456	0.298	0.061	0.312

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from individual-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.

Appendix Table A9 (continued). The ACA and the Circumstances of MVCs

	Automobile was under 1 Year Old	Automobile was over 5 Years Old	Automobile was over 10 Years Old	Deceased was wearing both Lap and Shoulder Seatbelt
Post x Uninsured	-0.018	0.080	0.152	0.081
	(0.037)	(0.091)	(0.113)	(0.092)
Post x Uninsured x Medicaid expansion	0.061	-0.094	-0.329	0.232
	(0.053)	(0.137)	(0.244)	(0.209)
<u>*Implied effects at mean pre-treatment uninsured rate*</u>:				
ACA w/o Medicaid expansion	-0.003	0.014	-0.027	0.015
	(0.007)	(0.016)	(0.020)	(0.016)
Medicaid expansion	0.012	-0.017	-0.059	0.042
	(0.010)	(0.025)	(0.044)	(0.038)
Full ACA (with Medicaid expansion)	0.008	-0.003	-0.032	0.056
	(0.007)	(0.018)	(0.039)	(0.034)
County fixed effects	yes	yes	yes	yes
State-by-year fixed effects	yes	yes	yes	yes
Observations	165,775	165,775	165,775	153,445
Mean of dependent variable	0.028	0.821	0.534	0.391

*Statistically significant at the .10 level; ** at the .05 level; *** at the .01 level.

Notes: OLS estimates from individual-level regressions are shown. Data are from the Fatality Analysis Reporting System (FARS) for the period 2010-2015. Standard errors, corrected for clustering at the state level, are in parentheses. Accidents that occurred in counties with a population of less than 10,000 are excluded from the analysis.