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Rate Regulation, Uninsured Driving and the Cost of Automobile Accidents

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Abstract

This paper examines the relationship between automobile insurance rate regulation and insured loss costs and uninsured driving rates. We use annual state-level data for the time period 1982-2003 to examine (i) the extent to which uninsured driving rates are sensitive to the stringency of rate regulation, and (ii) whether rate regulation is associated with increases in loss costs after changes in uninsured driving rates are accounted for. We find that more stringent regulation of insurance rates is associated with lower rates of uninsured driving. Higher rates of uninsured driving are associated with higher insurance costs, as expected if uninsured drivers shift accident costs to insured drivers. However, even after controlling for this effect, insurance costs are higher in more stringently regulated states. These findings suggest that regulatory rate suppression or cross-subsidies may encourage more universal automobile insurance coverage as intended, but may also produce other incentive distortions that lead to higher insurance costs.

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1. Introduction

Americans have had a love affair with their automobiles for more than one hundred years now. Apart from the visual appeal of their design, automobiles represent, among other things, freedom, adventure, and a means of transportation to work to earn a livelihood. But these benefits come at significant cost, including the cost of building and maintaining roadways, pollution from automobile exhaust, and traffic snarls.

Another important and highly politicized cost associated with automobile usage is the cost of accidents and their attendant injuries. Drivers impose negative externalities on others in the form of increased accident risk and accident costs (Edlin and Karaca-Mandic, 2006). The costs of accidents are internalized to some extent through the purchase of automobile liability insurance. Insurance theory indicates that if drivers behave so as to equate the marginal costs and benefits of driving, charging a premium equal to expected losses produces economically efficient outcomes. Under such a pricing scheme consumers who face greater accident risk face higher insurance premiums to reflect the greater risk they impose on the insurance system. However, pricing automobile insurance in this way could make insurance unaffordable for some drivers.

Drivers who cannot afford insurance are faced with two choices: refrain from driving or drive uninsured. When a driver chooses to drive uninsured, accident costs are shifted to other drivers if the uninsured driver does not have sufficient resources to pay. Because of this it can be shown that under limited liability low-wealth and/or high-risk drivers are the most likely to forego liability insurance (Shavell, 1987). The American view of driving as an entitlement or a necessity, coupled with concerns about uncompensated accident losses imposed by uninsured drivers, may be an important source of demand for rate regulation in automobile insurance markets. As evidence for this view, insurance rate regulation often maintains as one goal the assurance of affordable insurance coverage for all (or at least most) drivers.

In many states specific goals of rate regulation include reducing price variation across purchasers and reducing price levels for high-risk purchasers. To this end state regulations may limit risk classes, restrict price differences across risk classes, or restrict insurers' ability to deny coverage to high-risks. Additional restrictions on premiums charged to the highest-risk drivers arise through the operation of state residual markets that provide subsidized insurance to those who are unable to privately obtain coverage. The end result of such regulations is premium cross-subsidies across driver groups, with low-risk drivers paying higher premiums and high-risk drivers paying lower premiums than they would under a competitive pricing system.

Premium cross-subsidies are usually justified by fairness or altruism, or by political motives of regulators (Blackmon and Zeckhauser, 1991; Jaffee and Russell, 1998). In general, economic theory predicts that premium cross-subsidies will distort driving and insuring behaviors creating efficiency losses in the market. However, in some circumstances it can be shown that cross-subsidies may result in a constrained efficient outcome. In particular, if limited liability causes some individuals to remain uninsured while nonetheless choosing to drive, social welfare may increase if premium cross-subsidies induce these drivers to purchase insurance (Keeton and Kwerel, 1984, Smith and Wright, 1992).[1] Achieving a welfare increase relies on a number of assumptions that may not be satisfied in real-world markets, but if redistributive rate

[1] Premium cross-subsidies from low-risks to high-risks and resulting reductions in insurance coverage for low-risks may also arise in competitive equilibrium as a response to adverse selection (Wilson, 1977; Crocker and Snow, 1996).

regulation leads to lower uninsured driving rates there may be efficiency arguments in favor of the regulations.

Somewhat surprisingly, although the effects of automobile insurance regulation have been widely studied, there has been little study of its effect on uninsured driving. Using county level data in California Jaffee and Russell (1998) examine the relationship between premium levels and uninsured driving, but fail to find a significant relationship. Ma and Schmit (2000) also find no significant relationship in analysis of state-level data for 1987 and 1992.[2] However, using data from 27 cities Smith and Wright (1992) find a positive correlation between uninsured driving and premium levels in 1989. None of these studies directly examines the effect of rate regulation or regulatory cross-subsidies. Thus, whether automobile insurance regulation succeeds in reducing the rate of uninsured driving (or, on the contrary, increases it) is not well understood.

This paper examines the relationship between automobile insurance rate regulation, uninsured driving and the cost of insurance. Like Smith and Wright (1992), our research recognizes the potential feedback effects between uninsured driving and the cost of insurance. We examine regulatory cross-subsidies as a mechanism to alleviate the problem, providing empirical analysis of the relationship between the size of state uninsured driving, the cost of insurance, and premium cross subsidies (proxied with residual market data). We measure costs in terms of insured loss costs rather than premiums because of the potential for rate regulation to result in premiums that do not

[2] Cole, Dumm and McCullough (2001) also investigate the relationship between premiums and uninsured driving rates. However, premiums are taken into account as a factor (along with the percent of the population in urban areas and the percent of young male drivers), making it difficult to isolate the relationship between premiums and uninsured driving rates.

correspond to expected loss costs.[3] The focus on loss costs rather than price markups and/or insurer profits distinguishes this research from much previous research on automobile insurance regulation (e.g., Cummins, Phillips, and Tennyson, 2001; Grabowski, Viscusi, and Evans, 1989; and Harrington, 2002, among others).

This research is important for several reasons. First, although affordability is frequently given as motivation for automobile insurance rate intervention, little research exists indicating whether this intervention actually produces desirable results such as decreases in the uninsured driving population. Determining this relationship is the first vital step in determining the efficacy of rate regulation, in which the benefits of rate regulation (in terms of lower uninsured driver rates) must be weighed against the costs of regulation (in terms of accidents or loss costs associated with incentive distortions). Additional importance attaches to this question because automobile insurance is the largest single line of insurance in the U.S. Thus even small percentage increases in loss costs associated with rate regulation can translate into large sums of money.

This research uses a comprehensive data set and modern modeling techniques to study the relationship between the uninsured driving market and rate regulation. We examine (1) the extent to which uninsured driving rates are sensitive to the degree of regulatory intervention resulting in cross-subsidies or other distortions in insurance pricing; and (2) whether rate regulation is associated with higher loss costs after any effects of changes in uninsured driving rates are accounted for. These effects of rate regulation in automobile insurance markets are examined using a panel of state level data on uninsured driving and insured loss costs from 1982 to 2003.

[3] Rate regulation may artificially lower premiums to enhance affordability, for example. Also, the regulatory rate approval process itself can cause delays in implementation of proposed premiums.

By way of preview, we find evidence that premium cross-subsidies provided through the regulation of insurance rates are associated with lower rates of uninsured driving. Higher rates of uninsured driving are associated with higher loss costs per insured car. However, even after controlling for this effect insurance costs are higher in regulated states that provide premium cross-subsidies. These findings suggest that regulatory rate suppression or provision of cross-subsidies may encourage universal automobile insurance coverage, but produces additional incentive distortions that lead to higher insurance costs.

The remainder of this research proceeds as follows. Section 2 provides the institutional and theoretical background for our analysis. Section 3 develops the hypotheses to be tested and discusses our data and sample selection issues. Section 4 develops the empirical specifications and Section 5 provides econometric evidence on our hypotheses. Section 6 summarizes the main findings and their policy implications.

2. Background

2.1 Insurance Rate Regulation

The regulation of insurance markets in the United States is undertaken primarily by the individual states rather than by the federal government. Regulation has many common elements across the states, and states' regulatory activities are loosely coordinated through the National Association of Insurance Commissioners (NAIC). One regulatory area that varies greatly across states, however, is the extent to which insurance rates are regulated. A majority of states do not regulate insurance rates, and among those that do only select lines of insurance are regulated.[4]

[4] Common areas of rate regulation are health, automobile, homeowners and workers compensation insurance.

Rate regulation usually takes the form of "prior approval," under which insurers must obtain approval from the state insurance commissioner before introducing rates into the market. The commissioner reviews the filed rates and supporting documentation, and approves or denies the rate change proposed. The prior approval process usually requires insurers to demonstrate that their rates will produce a reasonable rate of return to insurers (as determined by the state), and are not unfairly discriminatory across driver rating categories. Currently 24 states regulate automobile insurance rates under prior approval systems of regulation (AIA, 2007).

Standard language in regulatory statutes requires the regulator to ensure that rates are neither "excessive" nor "inadequate." Rate adequacy protects insurer solvency and thus consumer access to insurance, as measured by both the availability of insurance policies and the payment of insurance claims. Rates that are not excessive promote affordability and assure that rates are in line with insurer costs. There are tensions inherent in these goals, of course, and regulatory emphasis varies across states (Cummins, Phillips and Tennyson, 2001; Meier, 1988). However, most studies of automobile insurance markets over the past two decades conclude that affordability receives greater emphasis, with rate regulation constraining premiums relative to loss costs at least in the short run (Grabowski, Viscusi, and Evans, 1989; Bouzouita and Bajtelsmit, 1997; Harrington, 1987).[5]

Insurance availability and affordability for the highest risk drivers are further protected through the operation of state residual markets for automobile insurance. Drivers in the residual market generally pay higher premiums than in the competitive

[5] Using annual data for 1972 to 1998, Harrington (2002) finds that over this long time period the average markups in rate-regulated states are about the same as those in unregulated states.

market, but less than the fair market premium; thus, residual market premiums involve subsidies from drivers in the voluntary market (Harrington, 1993; Jaffee and Russell, 1998). Suppression of average premiums below competitive market rates and compression of the premium distribution through subsidies to high risk drivers will lead to a larger proportion of drivers insured through the residual market. This is because drivers who are unprofitable to insure at voluntary market rates will be relegated to the residual market, and regulatory price restrictions increase this set of drivers. Because of this relationship, the size of the residual market in a state has come be seen as an important measure of the extent of regulatory premium subsidies.[6]

2.2 Rate Regulation, Uninsured Driving and Insured Loss Costs

Because of limited liability, drivers for whom the expected costs of accidents exceed their wealth may choose to drive uninsured (or less than fully insured). Those who will be most likely to face this decision are drivers who have low wealth, drivers who face a high risk of accidents, or both. Those drivers who choose to remain uninsured impose costs on insured drivers because the expected costs of accidents with uninsured drivers will be incorporated into insurance premiums through medical expense coverage, collision coverage, personal injury protection coverage (in no-fault states) and through uninsured/underinsured motorists coverage (Smith and Wright, 1992).

An example developed by Smith and Wright (1992) helps to illustrate this cost-shifting. Assume that all accidents involve two drivers, and the total cost of an accident for each driver is L; thus each accident involves total cost of 2L. The probability of an

[6] See Grace and Kwon (1996), Kaestner and Carroll (1997), Harrington and Danzon (2000) and Danzon and Harrington (2001) for studies of workers compensation insurance regulation; see Harrington (199), Bouzuita and Bajtelsmit (1997) and Weiss, Tennyson and Regan (2005) for studies in the automobile insurance context.

accident is p, and each driver is equally likely to be at fault. The at-fault driver is responsible for the total cost of the accident. If all drivers are insured the expected accident cost for each driver is 0.5p(2L) = pL, and the actuarially fair price of insurance will be pL. Now consider the expected cost to an insured driver of an accident with an uninsured driver who cannot pay the accident costs. In this case the insured drivers' insurance must cover her own accident costs, and the expected accident cost is 0.5p(2L) + 0.5p(L) = 1.5pL. Thus, the actuarially fair price of insurance depends upon the extent of uninsured driving, with premiums increasing as the proportion of uninsured drivers becomes larger.

Using this basic insight, Smith and Wright (1992) develop a theoretical model to show that when limited liability leads some drivers to forego insurance, insured drivers face expected accident costs. The resulting increase in actuarially fair insurance premiums can in turn reinforce the decisions of some drivers to remain uninsured. The authors show that under these circumstances it may be Pareto improving to offer premium subsidies to uninsured drivers, even if those subsidies must be financed by insured drivers. The societal gains come from the reductions in uncertainty borne by uninsured drivers, and from the reductions in insurance premiums paid by insured drivers, when previously uninsured drivers become insured. Keeton and Kweral (1984) develop similar results in a model in which limited liability leads to excessive entry into driving.The theoretical models provide valuable insights into possible market failures that could be rectified by rate regulation in automobile insurance markets. In practice, however, regulatory premium subsidies will be likely to create other distortions that could undermine the predicted benefits. For example, the theory assumes that subsidies are financed by nondistorting lump-sum taxes on insured drivers, which are not available in practice. Lump-sum taxes would assure that insured drivers' decisions regarding insurance purchase and driving are not affected by the premium increases associated with providing cross-subsidies. This is not likely to be true in all cases. Studies of unisex rating regulations in Canada find that the rating restrictions reduced insurance coverage among female (low-risk) drivers (Dahlby, 1983, 1992). Bartlett, Klein and Russell (1999) argue that premium cross-subsidies cause low-risk consumers to exit the insurance market, and provide historical evidence from several markets including automobile insurance.[7]

Additionally, the welfare gains that are possible in theory are based on assumptions that accident risk and claiming behaviors are unaffected by premium subsidies. However, the law and economics literature argues that reducing the links between accident risk and insurance prices, as will occur under regulated insurance premiums, will lead to reduced incentives for loss prevention and safety (Shavell, 1987). The net effect will be higher accident rates and higher loss costs in the insurance market.

A growing body of empirical evidence supports the idea that rate regulation leads to higher insurance costs. Several studies of workers compensation insurance document a link between stringent rate regulation and higher loss costs, premiums and worker injury rates (Danzon and Harrington, 2000; Harrington and Danzon, 2001; Barkume and Ruser, 2001). Similar results have been found in automobile insurance. Weiss, Regan and Tennyson (2005) find that average loss costs and claims rates per insured car are

[7] This question has received more attention in small group health insurance markets subject to community rating restrictions (Simon, 2007; Monheit, Steinberg and Schore, 2003; Buchmueller and DiNardo, 2002). Results from this literature are mixed, generally showing no strong relationship between community rating restrictions and levels of insurance coverage.

significantly higher in regulated states. Case studies of the heavily regulated auto insurance markets in Massachusetts (Tennyson, Weiss and Regan, 2002; Derrig and Tennyson, 2007) and South Carolina (Harrington and Pritchett, 1990; Grace, Klein and Phillips, 2002) demonstrate that during periods of stringent rate regulation loss costs in those states are substantially greater than would be expected based on other market characteristics.

An open question from existing research concerns the mechanism through which rate regulation leads to higher insurance costs. Providing evidence of a relationship between regulation and higher loss costs or accident rates does not prove the existence of the adverse safety effects often believed to be occurring. Of particular interest in this paper, if rate regulation induces previously uninsured drivers to purchase insurance and these drivers are higher risk, then average insured loss costs could increase as a result. If regulatory price distortions reduce uninsured driving but also reduce driver safety the resulting increases in accident rates and loss costs must be weighed against any gains associated with reducing uninsured driving.

3. Research Design

3.1 Hypotheses

As noted above, rate regulation that provides subsidies to high-risk drivers may alter a range of drivers' decisions regarding driving, insuring and safety. Although the separate effects of regulation on each of these decision margins is difficult to disentangle, we are especially interested in exploring the relationship between rate regulation and uninsured driving, because reducing uninsured driving provides a potential efficiency-enhancing argument for regulation. Empirical studies of automobile insurance have provided no evidence of this effect, and little evidence that rates of uninsured driving are even sensitive to the cost of insurance. In this paper we provide a direct test of the hypothesis that rate regulation which provides rate subsidies to high risk drivers and produces cross-subsidies among all drivers reduces uninsured driving.

> *Hypothesis 1: Greater regulatory cross-subsidies are associated with lower rates of uninsured driving, all else equal.*

Although provision of cross-subsidies can be economically efficient in theory, in practice it is difficult to institute a system of cross-subsidies that is consistent with the theory. Thus cross-subsidies are likely to create incentive distortions that lead to higher loss costs, even after controlling for their effect on insured driving. For example, if drivers' expected loss costs are not directly linked to premiums, incentives for safety are reduced. Thus Hypothesis 2 states,

> *Hypothesis 2: Greater regulatory cross-subsidies lead to higher insurance costs after controlling for the effects of uninsured driving.*

3.2 Variable Specification and Data

To test our hypotheses we study the market for private passenger automobile liability insurance in each state. Automobile liability insurance is studied because there is anticipated to be less variation in costs across states due to differences in insurance purchase for liability insurance than for total automobile insurance. We compile annual state-level data for 49 states over the years 1982 to 2003.[8]

Our measure of insurance costs is statewide average losses per insured car. Losses per insured car are constructed as total liability losses incurred divided by number of

[8] We omit New Jersey from the analysis because losses incurred in that state's residual market are not consistently reported in insurers' financial reports.

written car years. The losses include those insured under all automobile bodily injury insurance, including bodily injury liability, first party personal injury protection (PIP) in no-fault states, medical payments, and uninsured/underinsured motorist insurance; along with losses incurred under property damage liability coverage. Costs not included in the liability data series are first-party property damage losses incurred under collision and comprehensive insurance.

Because uninsured driving cannot be directly observed, we use two alternative approaches to its measurement. Our first measure is based on the number of uninsured motorist (UM) claims made by insured drivers, and is thus a measure of the percent of accidents involving an uninsured motorist. UM claims are a common measure of uninsured driving in the literature. Because accident frequency can vary substantially among states, UM claims are frequently normalized by another variable that is also related to accident frequency in a state, thus allowing for more direct comparison of this statistic across states.

UM claims are often normalized by the number of bodily injury liability (BI) claims as approximation of the percent of injury claims that involve an uninsured motorist. However, previous research has argued that the incentives to file BI claims may be distorted by general damages awards (e.g., Cummins and Tennyson, 1996; Crocker and Tennyson, 1998), and the number of BI claims will vary with tort thresholds in no-fault states (Cummins, Phillips and Weiss, 2002; Weisberg and Derrig, 1998). Because these effects may differ systematically across states, comparisons of statewide ratios of UM to BI claims may be biased. We choose instead to normalize UM claims by the number of property damage liability (PD) claims per insured car. Property damage liability claims are not subject to tort thresholds and do not lead to general damages, and thus are less subject to the incentive distortions that plague BI claiming. The number of UM claims divided by the number of PD claims provides an approximate measure of the percentage of all accidents that involve an uninsured motorist. For comparison purposes we also present estimates using the un-normalized UM claims rate and the UM to BI claims rate.

Measures of uninsured driving that are based on insurance claims may be influenced by claiming behavior and differences in accident risk among insured and uninsured drivers. For this reason we also examine an alternative measure of uninsured driving based on the number of vehicles insured. We construct this measure as the difference between the total number of registered vehicles in a state and year and the number of insured car years written, as a percentage of registered vehicles: (registered vehicles – insured car years)/registered vehicles. This ratio provides an approximate measure of the percent of motor vehicles on the road that are not covered by insurance.

Data on cross-subsidies by class of driver by state and year would be desirable to test our hypotheses. Unfortunately, such data do not exist. Therefore, this research follows the previous literature by measuring regulatory intervention in insurance pricing as the percentage of cars insured in the residual market in each state and year. As noted previously, residual markets tend to be much larger in rate regulated states than in other states, and residual market size has been related to the degree of rate suppression and rate compression imposed by regulation. If rate regulation distorts insurance rates away from cost-based rates, insurers will tend to reject risks for which the difference between loss costs and regulated rates is the largest. These rejected risks will then be insured in the state residual market. Additionally, the greater the subsidies offered to risks insured in the residual market, the greater will be the demand for residual market insurance relative to the voluntary market (Jaffee and Russell, 1998).

A potentially important factor to take into account is state laws that make automobile liability insurance compulsory for all drivers. Compulsory insurance laws are one way that states can attempt to deal with the externality of uninsured driving, and over time states have moved to make automobile liability insurance compulsory. Ma and Schmit (2000) find that state compulsory insurance laws have a significant effect on uninsured driving, with stronger laws resulting in lower rates of uninsured driving.

Other controls in our empirical models include state demographics such as per capita income and population age distribution; state characteristics such as traffic density and public transportation miles per capita; and insurance laws such as minimum liability limits, no-fault benefits, and maximum personal injury protection payments under no-fault and add-on insurance laws.

Data on automobile liability insurance costs is obtained from insurers' annual statements reported to the NAIC. Data on uninsured driving are obtained from *Uninsured Motorists*, published periodically by the Insurance Research Council (IRC). We supplement these data with state-level data on the size of the voluntary and residual automobile insurance markets, obtained from the Automobile Insurance Plans Service Office (AIPSO) annual *Fact Book.* Other features of state auto insurance laws are obtained from the Insurance Information Institute (III) annual *Fact Book, Property/Casualty Insurance Edition*, and from *State Automobile Insurance Laws and Regulations* published by the American Insurance Association (AIA). Data for public transportation (commuter rail) miles are obtained from the National Transit Database. All other data are obtained from the *Statistical Abstract of the U.S.* More specific information about the sources and definitions of these variables are described in a Data Appendix available from the authors. Summary statistics for all variables included in the regression models are reported in Table 1.

(Insert Table 1 about here)

4. Econometric Methods

The econometric methodology used in this study is regression analysis of uninsured driving rates and average loss costs per car. However, the use of single equation estimates suffers from several shortcomings for this study. The first is that the size of the residual market in the state may be jointly determined with the outcome variables. In particular, regulators may increase the stringency of regulation in response to high average loss costs, or may increase regulatory stringency to pursue lower rates of uninsured driving. If this is the case the residual market variable will be endogenous in our models.

Additionally, as discussed previously insured loss costs will depend on rates of uninsured driving, distinct from any effects that consumers' insurance choices have on the size of the residual market. Because insurance choices will also depend on regulated rate subsidies and/or cross-subsidies – uninsured driving rates will themselves be a function of residual market size. A final consideration is that uninsured driving may depend on insurance costs in a manner that is distinct from the impact of regulatory price distortions. That is, in deciding whether to purchase insurance consumers will take into account the cost of insurance. Although several existing studies of the demand for insurance have not found insurance price to be a significant determinant of uninsured driving rates (Ma and Schmit, 2000; Jaffee and Russell, 1998), economic theory nonetheless predicts a relationship. These inter-relationships suggest the need to estimate a system of equations.

The system of equations that are estimated can be stated in their simplest form as

$$\text{Insurance costs} = f(R, \text{Uninsured}, X_1) \text{ and}$$

$$\text{Uninsured} = g(R, P, X_2)$$

where R is regulatory stringency, Uninsured is a measure of the prevalence of uninsured driving, P is premiums per car = h(insurance costs, insurer expenses and profit), and X_1 and X_2 are vectors of exogenous factors. A reduced form system of equations in which insurance costs per car and insurer expenses and profit are substituted for premiums per car is used in the estimation:

$$\text{Insurance costs} = f(R, \text{Uninsured}, X_1) \quad \text{and}$$

$$\text{Uninsured} = g(R, \text{Insurance costs}, Z, X_2),$$

where Z is a vector of factors expected to affect insurer expenses and profit.

The system that is estimated can be stated in a statistically more formal way as

$$Ln(Insurance\ Costs)_{st} = \alpha_a + \beta_{a1} Ln(Residual\ Market\ Size)_{st} + \beta_{a2} Ln(Uninsured)_{st} + \gamma_a' Ln(X_1)_{st} + State_s + Year_t + e_{ast} \quad (1)$$

$$Ln(Uninsured)_{st} = \alpha_b + \beta_{b1} Ln(Residual\ Market\ Size)_{st} + \beta_{b2} Ln(Insurance\ Costs)_{st} + \gamma_b' Ln(X_2)_{st} + State_s + Year_t + e_{bst} \quad (2)$$

The endogenous variables are $Ln(Insurance\ Costs)_{st}$, $Ln(Uninsured)_{st}$, and $Ln(Residual\ Market\ Size)_{st}$. Excluded instruments for the residual market variables are the annual change in residual market size from the last year to the current year, and the lagged value of this annual change. Standard tests indicate that these instruments are exogenous and are strongly related to current residual market size when tested in each of the equations separately.[9] Exogenous variables that appear in only one equation in each system serve as instruments for the other endogenous variables.[10]

We assume that each of the dependent variables depends upon the size of the residual market and other state time-varying characteristics associated with their automobile insurance markets, along with unobserved time-invariant state characteristics (state fixed effects) and national effects that are common to all states (year fixed effects). All continuous variables are measured in logarithms and all dollar-valued variables are converted into 2003 values.

Higher per capita income is expected to increase the demand for insurance, and to increase insurance limits purchased, and thus to increase insurance costs. Higher traffic density and more individuals aged 18-24 are expected to increase accident risk and thus to increase insurance costs. Higher minimum liability coverage limits per person are expected to increase average insurance costs through their impact on the amounts of insurance purchased by the average driver. Similarly, in no-fault and add-on states, the maximum personal injury protection (PIP) coverage limits are expected to be positively related to insurance costs due to their effects on insurance payments under those coverages. These limits are included in the equation rather than a simple dummy variable

[9] For each equation the first stage partial F-statistic (Cragg-Donald Wald F-statistic) rejects the weak-instrument hypothesis for the excluded instruments. In the uninsured equations in Table 2, the F-statistic varies from 88.05 to 90.04. In the Loss Cost equation the F- statistic is 95.34. The Sargan statistics for each model are never significant at even the 10 percent confidence level, indicating that the excluded instruments are valid.

[10] In the Loss Cost equation the identifying variables are traffic density, person liability minimum limits, maximum PIP payments and the proportions of the state population under age 18 and over age 75. In the Uninsured equation the compulsory and no-fault insurance dummy variables, gas tax per gallon, per capita public transportation miles and average property-casualty insurance wage serve as identifying variables.

for no-fault and/or add-on insurance due to previous research that has found the effect of no-fault insurance laws to vary across states (Cummins, Phillips and Weiss, 2001). The unemployment rate is expected to be negatively related to insurance costs because on average unemployed workers have less need to drive (e.g., to work) and less discretionary income to spend enjoying the benefits of driving. The proportion of the population over age 75 is expected to be negatively related to insurance costs, as older individuals are expected to drive less overall.

In the Uninsured equation, a compulsory insurance law is expected to decrease the rate of uninsured driving by making uninsured driving more difficult (Keeton and Kweral, 1984; Cohen and Dehejia, 2002). Higher per capita income is expected to decrease the demand for uninsured driving. The impact of no-fault insurance on uninsured driving is uncertain, but may reduce uninsured driving since it provides more first-party benefits than tort-based insurance. The unemployment rate is expected to be positively associated with uninsured driving because unemployed workers should find insurance coverage more expensive. Greater availability of public transportation is expected to decrease uninsured driving since it decreases the cost of alternative transportation, while a higher gas tax rate is expected to decrease uninsured driving by making driving more expensive. Average weekly wages of property-casualty insurance workers are included as a measure of insurer expenses over and above loss costs; higher expenses will increase insurance premiums and thus are expected to be positively related to uninsured driving.

5. Estimation Results

The 3SLS estimation results for the systems of equations are reported in Table 2 and Table 3. Table 2 presents the estimates of the uninsured driving equation in the system, and Table 3 presents the estimates of the costs per insured car equation. Estimation results for each equation are presented using alternative measures of the uninsured driving rate: the UM claims rate, the ratio of UM claims to PD claims, the ratio of UM claims to BI claims and the ratio of uninsured vehicles to total vehicles.

5.1 Uninsured Driving Rates Results

In Table 2 we observe that the residual market variable is negative in all models and statistically significant in three of the four models. These results support the hypothesis that states' provision of premium subsidies to some drivers is associated with lower rates of uninsured driving. Compulsory insurance laws are also related to significantly lower rates of uninsured driving, but this variable is statistically significant only when uninsured driving is measured in terms of vehicles rather than claims. This is consistent with the idea that compulsory insurance laws may keep some uninsured vehicles off the roads, but that drivers who choose to drive uninsured pose a higher than average accident risk. Contrary to the findings of previous studies, our estimates show that the rate of uninsured driving is sensitive to the cost of insurance. That is, the coefficients for average loss cost per car are positive and significant in all models, and losses are the largest component of premiums. Our results are thus consistent with theoretical predictions that higher insurance costs will lead to higher rates of uninsured driving.

(Insert Table 2 about here)

5.2 Average Loss Costs per Car Results

The estimates in Table 3 are also consistent with theoretical predictions. Here we observe that average losses per insured car are positively affected by the rate of uninsured driving, irrespective of the measure of uninsured driving that is used. And, even after accounting for this effect, a larger residual market size is positively associated with average loss costs and significant in each model as well. These results are consistent with prior research which indicates that rate regulation is associated with higher average loss costs. However, our results provide stronger evidence that this association is due to adverse incentive distortions because we demonstrate an impact of rate regulation on the cost of insurance even after controlling for the effect of uninsured driving on those costs. Thus, while regulatory premium subsidies do have the desired effect of reducing uninsured driving rates, they appear to create other incentive distortions that raise the cost of insurance for all drivers.

(Insert Table 3 about here)

5.3 Other Results

In the uninsured equations, uninsured driving rates are positively related to the no-fault state dummy and unemployment rate as expected. And some evidence is provided that uninsured driving is negatively related to income per capita. In the loss cost equations, loss costs are negatively related to the unemployment rate in most models and positively related to the maximum PIP payment in add-on states in all models, as expected. In some models, loss costs are positively related to real income per capita, the maximum PIP payment in no-fault states, and the liability minimum limit per person, as expected. Loss costs are negatively related to the proportion of the population aged over 75 as expected, but this variable is significant in only one equation.

6. Conclusion

A growing body of empirical evidence demonstrates that loss costs and accident rates in states that stringently regulate property-liability insurance rates are higher than those in other states and higher than would be expected based on other market characteristics of the regulated states. What has remained unanswered in this literature is the source of these higher costs. It is of particular interest to public policymakers to know whether rate regulation leads to higher costs because more high risk consumers are drawn into the insurance market. If this is the source of cost growth then the higher costs must be weighed against the benefits of a move toward universal insurance coverage.

This research has begun to explore that question. Our analysis of annual state level data from 49 states over the period 1982-2003 indicates a significant relationship between more stringent regulation and the rate of uninsured driving. However, after controlling for the rate of uninsured driving, our estimates still show a positive and significant effect of more stringent rate regulation on average loss costs in a state and year. These findings suggest that one effect of regulatory rate suppression or provision of cross-subsidies is to produce incentive distortions among insured drivers that lead to higher insurance costs. These results suggest that rate regulation is not having the unambiguous positive impact on the automobile insurance market that is intended.

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Table 1

Summary Statistics
Forty-nine States, 1982 to 2003

Variable	Mean	Standard Deviation
UM Claims Rate	0.1654	0.1125
UM/PD Claims Rate	4.1656	2.9024
UM/BI Claims Rate	0.1363	0.0689
Uninsured MVR/MVR	0.2446	0.1051
Average Loss per Insured Car	$318.79	$115.41
Residual Market Share	0.0298	0.0795
Compulsory Insurance Law (=1 if law)	0.7597	0.4274
Real Income per Capita	$25,684	$4,848
Per Capita Public Transportation Miles	0.0363	1.0112
No Fault Indicator (=1 If No-Fault)	0.2597	0.4387
Unemployment Rate	5.9266	2.1209
Gas Tax per Gallon	$17.16	$5.36
Avg Weekly Wages, Property-Casualty Insurers	$683.93	$227.69
Traffic Density	0.6128	0.4218
Population Percent Aged 18-24	0.1140	0.0269
Person Liability Minimum Limit (in 000s)	$27.83	$10.30
Max PIP Payment, Nofault states	$17,432	$60,640
Max PIP Payment, Addon states	$1,418	$3,886
Population Percent Over Age 75	0.0541	0.0123

Note: UM Claims Rate is the number of UM claims per 1000 insured cars. UM/PD Claims Rate is the number of UM claims divided by the number of property damage liability claims in the state voluntary market; UM/BI Claims Rate is the number of UM claims divided by the number of bodily injury liability claims; Uninsured MVR/MVR is (MVR-number of insured cars)/MVR, where MVR is total motor vehicle registrations; Avg. loss per car is incurred losses for bodily and property damage liability losses incurred divided by car years written; Residual market size is the proportion of written car years in the state residual market. Compulsory Insurance dummy is a dummy variable equal to one if a state has a compulsory automobile insurance law, and zero otherwise. Real Income per Capita is expressed in real 2003 dollars. No-fault Indicator is a dummy variable equal to one if a state has a nofault law, and zero otherwise. Gas Tax per Gallon is the state gas tax per gallon rate; Avg Weekly Wages, Property-Casualty Insurers is the average weekly wage for SIC 6331 (NAIC 524126); Population Pct Aged 18-24 is the proportion of the state population aged between 18 and 24 years old; Population Pct over Age 75 is the proportion of the population aged 75 years old or above. Per Capita Public Transportation Miles is the annual number of commuter train miles supplied in the state per capita. Per Capita Federal Transportation Aid is federal grants to Highway Trust Funds and Urban Mass Transportation Administration per capita; Person Liability Min. Limit is the statutory minimum limit for liablity to a person per automobile accident; Max PIP Pmt, No-fault (Add-on) states is the maximum statutory payment for personal injury protection in no-fault (add-on) states; and traffic density is number of automobile vehicle miles divided by miles or roadway in the state. New Jersey is omitted due to data availability.

Table 2
Three-Stage-Least-Squares Results
Forty-Nine State Sample, 1982 to 2003
Dependent Variable: Ln(Uninsured Driving)

Dependent Variable:	**Ln(UM Claims Rate)**	**Ln(UM/PD Claims Rate)**	**Ln(UM/BI Claims Rate)**	**Ln(Uninsured MVR/MVR)**
Independent Variable	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
Ln(Average Loss per Car)	2.9060 ***	1.3668 ***	0.7008 ***	0.5680 *
	13.42	6.40	3.73	1.81
Ln(Residual Market Share)	-0.1226 **	-0.1736 ***	-0.0397	-0.2117 ***
	-2.10	-3.97	-1.10	-2.85
Compulsory Insurance Law	-0.0315	-0.0180	-0.0255	-0.0963 **
Indicator (=1 if law)	-1.35	-0.85	-1.43	-2.03
Ln(Real Income per Capita)	-0.5900 **	-0.1096	-0.1861	-0.3718 *
	-2.15	-0.55	-1.12	-1.78
Ln(Per Capita Public Trans-	0.0012	0.0018	-0.0009	-0.0057
portation Miles)	0.17	0.28	-0.18	-0.45
No-Fault State dummy	0.1482 *	-0.1450 **	0.0708	0.0131
	1.70	-2.26	1.30	0.12
Ln(Unemployment Rate)	0.3524 ***	0.1360 **	0.0859 *	-0.0543
	4.87	2.55	1.88	-0.67
Ln(Gas Tax per Gallon)	-0.1077 **	0.0704	0.0531	0.0960
	-2.41	1.56	1.48	1.13
Ln(Avg Weekly Wages, Property-	0.0890	0.0254	-0.0300	0.0002
Casualty Insurers)	0.95	0.28	-0.39	0.00
Fixed Effects	Yes	Yes	Yes	Yes
CD-Wald Statistic	95.3400	95.3400	95.3400	86.18
Sargan Statistic	0.1270	0.1270	0.1270	0.4500
No. of observations	1078	1075	1078	1066
R-Squared	0.35	0.88	0.81	0.94

Note: t-statistics appear below the coefficients. *, **, *** significant at 10%, 5% and 1% confidence level, 2-sided tests.

Note: UM Claims Rate is the number of UM claims per 1000 insured cars. UM/PD Claims Rate is the number of UM claims divided by the number of property damage liability claims in the state voluntary market; UM/BI Claims Rate is the number of UM claims divided by the number of bodily injury liability claims; Uninsured MVR/MVR is (MVR-number of insured cars)/MVR, where MVR is total motor vehicle registrations; Insured MVR/MVR is total insured cars divided by MVR; Average loss per car is incurred losses for bodily and property damage liability losses divided by car years written; Residual market size is the proportion of written car years in the state residual market. Compulsory Insurance Law is a dummy variable equal to one if a state has a compulsory automobile insurance law, and zero otherwise. Real Income per Capita is expressed in real 2003 dollars. No-fault Indicator is a dummy variable equal to one if a state has a no-fault law, and zero otherwise. Gas Tax per Gallon is the state gas tax per gallon rate; Avg Weekly Wages, Property-Casualty Insurers is the average weekly wage for SIC 6331 (NAIC 524126); New Jersey is omitted due to data availability.

Table 3
Three-Stage-Least-Squares Results
Forty-Nine State Sample, 1982 to 2003
Dependent Variable: Ln(Average Loss Per Car)

Dependent Variable:	**Ln(Avg Loss Per Car)**	**Ln(Avg Loss Per Car)**	**Ln(Avg Loss Per Car)**	**Ln(Avg Loss Per Car)**
Uninsured driving measure:	Ln(UM Claims Rate)	Ln(UM/PD Claims Rate	Ln(UM/BI Claims Rate)	Ln(Uninsured MVR/MVR)
Independent Variables	**Coeff.**	**Coeff.**	**Coeff.**	**Coeff.**
Ln(UM Claims Rate)	0.2188 ***	0.4807 ***	0.6950 ***	0.2744 ***
	18.67	8.34	8.22	2.74
Ln(Residual Market Share)	0.0616 ***	0.1336 ***	0.0975 ***	0.1828 ***
	3.43	6.26	4.26	5.67
Ln(Real Income per Capita)	0.1486	0.0995	0.2334 **	0.4481 ***
	1.64	0.97	2.11	14.64
Ln(Traffic Density)	0.0159	-0.0141	-0.0395	-0.0031
	0.80	-0.51	-1.26	-0.05
Ln(Population Pct Aged 18-24)	-0.0008	0.0195	0.0323	0.0162
	-0.03	0.60	0.90	0.28
Ln(Unemployment Rate)	-0.0987 ***	-0.0954 ***	-0.0993 ***	-0.0339
	-4.33	-3.89	-3.62	-1.14
Ln(Person Liability Min. Limit)	-0.0038	0.0645 ***	0.1057 ***	0.1690 ***
(in 000s)	-0.25	3.00	4.44	6.10
Ln(Max PIP Pmt, No-Fault states)	0.0042	0.0066 *	-0.0059	-0.0015
	1.41	1.78	-1.60	-0.40
Ln(Max PIP Pmt, Addon states)	0.0059 ***	0.0070 **	0.0067 *	0.0150 ***
	2.61	2.26	1.88	3.43
Ln(Population Pct Over Age 75)	-0.0367	-0.0671	-0.0931 *	-0.0762
	-1.17	-1.41	-1.84	-1.24
Fixed Effects	Yes	Yes	Yes	Yes
CD-Wald Statistic	90.04	88.05	90.04	95.34
Sargan Statistic	1.5670	1.7090	0.8660	0.127
No. of observations	1078	1075	1078	1066
R-Squared	0.90	0.83	0.76	0.942

Note: t-statistics appear below the coefficients. *, **, *** significant at 10%, 5% and 1% confidence level, 2-sided tests.

Note: UM Claims Rate is the number of UM claims per 1000 insured cars. UM/PD Claims Rate is the number of UM claims divided by the number of property damage liability claims in the state voluntary market; UM/BI Claims Rate is the number of UM claims divided by the number of bodily injury liability claims; Uninsured MVR/MVR is (MVR-number of insured cars)/MVR, where MVR is total motor vehicle registrations; Avg. loss per car is incurred losses for bodily and property damage liability losses incurred divided by car years written; Residual market size is the proportion of written car years in the state residual market. Real Income per Capita is expressed in real 2003 dollars. Population Pct Aged 18-24 is the proportion of the state population aged between 18 and 24 years old; Population Pct over Age 75 is the proportion of the population aged 75 years old or above; Person Liability Min. Limit is the statutory minimum limit for liablity to a person per automobile accident; Max PIP Pmt, No-fault (Add-on) states is the maximum statutory payment for personal injury protection in no-fault (add-on) states; and traffic density is number of automobile vehicle miles divided by miles of roadway in the state NJ is omitted due to data availability. Ln refers to natural logarithm.