Online citation: Weisheit, Ralph A. and L. Edward Wells. 2010. "Methamphetamine Laboratories: The Geography of Drug Production." *Western Criminology Review* 11(2):9-26. (http://wcr.sonoma.edu/v11n2/Weisheit.pdf).

Methamphetamine Laboratories: The Geography of Drug Production

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Abstract: *There has been considerable public concern and legislative activity surrounding the issue of domestic methamphetamine production. What has not been extensively examined is the broader context within which domestic methamphetamine production takes place. This study utilizes geographic location data on 14,448 seized methamphetamine laboratories to document the association between the presence of methamphetamine labs and economic factors, social factors, and crime. The study shows that laboratory seizures spiked upward immediately prior to the implementation of legislation restricting access to methamphetamine precursor drugs and declined immediately after the legislation was passed, remaining well below pre-regulation levels. However, more than a third of U.S. counties reported laboratory seizures after strict precursor regulations were in place, suggesting that while the problem of local methamphetamine lab production was diminished by precursor regulation, it was not eliminated.*

The study also examined factors most strongly associated with the seizure of methamphetamine laboratories at the county level. Economic instability was not a good predictor of the presence of methamphetamine labs, nor were spatial or geographic variables. In general, counties with higher lab seizure rates tended to have a predominantly White, English-speaking population with a substantial representation of evangelical churches. Methamphetamine laboratory counties also tended to have employment based on manufacturing, a larger farm population, single-female-headed households, a higher than average property crime rate, be more racially segregated, have a population that moved into the household within the past year, and have a higher percent of occupied housing. In sum, neither traditional measures of social disorganization nor measures of civic engagement consistently predict the presence of methamphetamine labs.

Keywords: methamphetamine, laboratories, drugs, stimulants, drug production, drug crime, geography, precursors, rural, drug seizures

INTRODUCTION

Methamphetamine is a powerful central nervous system stimulant, part of a larger family of stimulant drugs that includes amphetamine, cocaine, methylphenidate, ephedrine and ecstasy. The general effects of all stimulant drugs are the same, although the effects of methamphetamine last longer, and the drug is more potent (i.e., it takes a smaller amount to generate the same effect) than other drugs in this category. The methamphetamine user rapidly develops a tolerance for the drug, requiring increasingly large doses to achieve the same effect. Common physiological effects include intense feelings of well-being and confidence, paranoia, appetite suppression, extended periods of wakefulness, and an accelerated heartbeat (cf. Weisheit and White 2009). Unlike heroin or cocaine, methamphetamine can be easily and inexpensively manufactured within the U.S. with little equipment, few supplies, and almost no expertise in chemistry. The production process creates its own set of unique problems for the environment and the community.

A BRIEF HISTORY

Methamphetamine was first synthesized in 1919 and for decades, was legally manufactured as a drug erroneously thought to be safe and nonaddictive. Early recreational users of the drug found it easy to get from doctors or from supplies diverted from the licit market. In response to concerns about the drug's abuse, drug makers withdrew injectable methamphetamine from the market in the early 1960s, leaving users without a ready supply of the drug (Miller 1997:116). As a result of this unmet demand, the first illicit methamphetamine laboratories emerged in San Francisco in 1962 or 1963, perhaps with the help of some legitimate chemists (Brecher 1972; Smith 1969; Miller 1997). Eventually, methamphetamine production made its way along the entire west coast from San Diego to Washington State. From there, production moved eastward so that today methamphetamine labs have been found in every state.

Concerns about Meth Labs

While methamphetamine has been around for nearly a century, the rise of domestic methamphetamine laboratories has added a sense of urgency in responding to the problem. Methamphetamine laboratories pose environmental and health risks that transcend the effects of the drug on the user. Apartment residents may be killed or injured by a meth lab explosion in the adjoining apartment, children in homes where meth is cooked may be exposed to toxic chemicals and to meth itself, hotel guests may be injured by toxic chemical residue from the previous tenant's meth lab, children may be burned or seriously injured by the meth trash dumped along the roadways near their homes, and emergency responders may be sickened when they enter a lab site. Further, producing one pound of methamphetamine generates five to six pounds of toxic waste (Hargreaves 2000), waste that may contaminate the ground or water supplies. Thus, meth labs pose a type of threat to innocent citizens that simple drug use does not.

Ways of Cooking and the Government's Response

There are hundreds, perhaps thousands, of recipes for manufacturing methamphetamine, but most is produced in one of three processes – P2P, Red Phosphorous, or Anhydrous. The P2P method, as the name implies, is based on the chemical P2P (phenylacetone or phenyl-2-propanone) and methylamine (a derivative of ammonia). Both the Red Phosphorous (aka Red P method) and Anhydrous (aka Nazi or Birch method) are ephedrine/pseudoephedrine reduction methods. That is, they take ephedrine (a decongestant found in many cold medicines) and remove an oxygen molecule to produce methamphetamine. These ephedrine reduction methods are substantially simpler to do and rely on chemicals commonly found in agricultural communities.

Originally, much of the methamphetamine produced in the U.S. was made with the P2P method. In February of 1980, the U.S. government placed restrictions on P2P and more carefully monitored the sale of methylamine. As P2P became more difficult to obtain, the ephedrine reduction methods became more popular (DEA n.d.). As producers moved to the use of ephedrine in over-the-counter pill form, states began enacting legislation to limit precursor chemicals. California was the first, with its legislation going into effect in January of 2000. Other states followed California's lead. In 2005 alone, 35 states enacted legislation to restrict the sale of ephedrine and pseudoephedrine, with another 6 states enacting legislation in 2006 (National Alliance for Model State Drug Laws 2006). By the end of 2007, only 7 states had no such law, and each of those states was in the Northeast, where methamphetamine production had not yet taken hold. These laws generally regulated the display of ephedrine products, restricted who could buy and sell such products, the amount that could be sold within a specific time frame, and the manner in which ephedrine products were packaged.

The *Combat Methamphetamine Epidemic Act of 2005* was the federal government's response to the use of over-the-counter pills to manufacture methamphetamine. Taking effect in early 2006, the law required those who purchase such pills to provide a photo ID and sign for the purchase, and limits the amount that can be purchased each month. Perhaps as a reflection of the level of public concern about methamphetamine laboratories, the title of the federal act includes the word "epidemic."

Efforts to control precursors and to increase penalties for the manufacture of methamphetamine have undoubtedly played a role in reducing the number of domestic methamphetamine laboratories, though the precise extent of that impact is unclear. The 2009 *National Methamphetamine Threat Assessment* report indicates that the number of domestic methamphetamine laboratories increased in 2008 (National Drug Intelligence Center 2009). One state, Indiana, saw a 31 percent increase in the number of methamphetamine laboratories seized between 2007 and 2008 ("Indiana Sees Surge in Meth Production" 2009).

THE SOCIAL CONTEXT OF METHAMPHETAMINE PRODUCTION

While there is a large body of research on the physiological effects of methamphetamine and on the drug's effects on behavior (cf. Weisheit and White 2009), there has been surprisingly little research on methamphetamine laboratories. What has been done focuses primarily on the environmental impact of the chemicals used in methamphetamine production (e.g., the series of studies by John Martyny and his associates 2004a; 2004b; 2004c; 2005a; 2005b).

The effect of precursor regulation on overall levels of methamphetamine consumption is much debated. Using data from California, one the first states to implement precursor restrictions, Cunningham and Liu (2003) argued for the effectiveness of these measures, noting that methamphetamine-related hospital admissions had gone down following legal restrictions to access to precursors. Reuter and Caulkins (2003) raised doubts about these claims, noting that other measures suggested no effect of these regulations. For example, following precursor regulation, the price of methamphetamine in California went down, when there should have been shortages of the drug that drove prices up. Similarly, there were no sharp reductions in the reported use of methamphetamine by newly admitted jail inmates.

In a 2005 study, Cunningham and Liu returned to the issue by examining the association between various efforts to limit access to precursors and arrests for methamphetamine in California between 1982 and 2001. They found that restrictions affecting large-scale producers led to a reduction in the number of arrests for a short period, followed by a rebound. Restrictions affecting small-scale producers had no impact on the number of methamphetamine arrests.

Interviews with methamphetamine users and cooks in Arkansas and Kentucky found that local production did decline after restrictions on the sales of pseudoephedrine, to be at least partially replaced by imported methamphetamine. Interestingly, the cooks in this study did stop cooking but attributed this to concerns about arrest, family pressures, and health concerns – not to the difficulty in obtaining pills (Sexton et al. 2008).

In what is perhaps the most detailed study to date, Dobkin and Nicosia (2009) considered the impact of a major disruption in the supply of precursors on a variety of methamphetamine-related indicators in California. In the months immediately following this disruption, the price of methamphetamine rose from $30 to $100 a gram, purity dropped from 90 percent to less than 20 percent, hospital admissions declined by 50 percent, treatment admissions declined by 35 percent, felony arrests for methamphetamine possession fell by 50 percent, misdemeanor arrests for methamphetamine possession fell by 25 percent, and the percent of arrestees testing positive for methamphetamine declined by 55 percent. All of these changes occurred with no evidence that users were switching to other drugs. Unfortunately, the impact of this major precursor disruption was short lived as new sources of precursors were identified. “Price returned to pre-intervention levels within four months while purity, hospital admissions, drug treatment admissions and drug arrests recovered to near pre-intervention levels over eighteen months” (Dobkin and Nicosia 2009:325).

Only one study examined the association between the county-level presence of methamphetamine laboratories and broader social and economic factors. Weisheit and Fuller (2004) examined simple bivariate correlations between the presence of a methamphetamine laboratory in any of 102 counties in Illinois and a host of social factors. They found that the presence of a methamphetamine laboratory was not associated with the property crime rate, violent crime rate, the delinquency petition rate, or the drug arrest rate. However, methamphetamine laboratories were associated with the rate of reported child abuse and neglect, teen births as a percent of all births, the truancy rate, and the percent of youth living in poverty. Methamphetamine laboratories were also associated with several economic variables, including the median household income, the per capita property tax rate, and the percent of homes without a telephone. The study by Weisheit and Fuller is suggestive. It is limited, however, in that it only considers the pattern in one state and only considers bivariate associations. This study extends the work of Weisheit and Fuller by using a large national data set and by going beyond simple bivariate associations.

THE CURRENT STUDY

This study expands on prior research using local single-state samples (e.g., California and Illinois) by drawing upon a national data base of seized drug laboratories and linking that data base with data on crime, economic factors, and social factors in the local communities where the labs were found. The analytic aims of the study are avowedly exploratory and descriptive, i.e., to empirically document regional and national patterns in the presence of methamphetamine laboratories, to describe the changes associated with precursor regulations, and to establish an empirical risk-factor profile of communities with methamphetamine laboratory problems. Following an empirical description of the distribution of clandestine laboratories across the U.S., the study utilizes national-level data to examine: (1) trends in methamphetamine laboratory seizures in recent years both nationally and regionally, (2) changes in the number of laboratories associated with the passage of state and federal regulations restricting access to ephedrine-based precursors, and (3) patterns of association between social, physical, and economic characteristics of counties and the presence of methamphetamine laboratories.

The Data

This study utilizes several sources of data, including the DEA’s *National Clandestine Laboratory Registry*, crime data from the *Uniform Crime Reports*, social and economic data from the U.S. Census Bureau, data from a national survey on religion, data on the proximity of major highways to each U.S. county, and data on the location of prisons and Indian reservations in counties.

The *National Clandestine Laboratory Registry* is maintained by the DEA with information supplied by agencies throughout the United States (DEA 2009). The data include the state, county, city, address, and the date on which each lab or lab waste dump site was discovered. The data set includes 14,448 cases from January 2004 through September 2008. As with any official count of crime, the data are not a complete listing of all laboratories. Having said that, no data set exists that is a more comprehensive compilation of clandestine laboratories. The data do not distinguish clandestine methamphetamine laboratories from other clandestine drug laboratories but it is likely that nearly all of the laboratories are related to methamphetamine. A 2002 study of narcotics agents who respond to clandestine drug laboratories found that 88 percent of the labs they entered were methamphetamine labs (Burgess et al. 2002). Further, figures provided by the 2008 Annual Report of the Office of National Drug Control Policy (ONDCP n.d.) show that 98-99 percent of seized labs are small-scale operations.

Each methamphetamine lab seizure listed in the National Clandestine Laboratory Registry was recorded in a Microsoft Excel spreadsheet by the date of the seizure and its geographic location. The street address, city, county, and state of each lab seizure were recorded along with the Federal Information Processing Standards (FIPS) codes for county and state. From a separately created file of state precursor regulation implementations – obtained from the National Association of Chain Drug Stores (NACDS 2008) – we added the effective date of precursor regulation/prohibition for the state in which the lab seizure occurred. For states with no state-level restrictions, the date on which federal restrictions went into effect was used (March 9, 2006). Using this precursor regulation date, each lab seizure was coded as either a pre- or post-regulation event. These basic lab seizure data were then imported into SPSS for data file management and statistical analysis and then merged with additional information regarding the state and county where the lab seizure occurred. These additional data included: (a) state-level methamphetamine use rates from the National Survey of Drug Use and Health for 2002 through 2005 (SAMSHA 2006); (b) geographic region and metropolitan area codes from the U.S. Census Bureau (2008); (c) Rural-Urban continuum codes and Rural Typology codes from the Economic Research Service of the U.S. Department of Agriculture (Economic Research Service 2003; 2004).

The individual lab seizure data also were aggregated by counties and by states to yield two additional data files containing lab seizure frequencies and rates at the county and the state levels. Using the state+county FIPS codes, additional variables were merged with the county-level data file to provide a more detailed description of the community context where the lab seizures occurred. In addition to the basic data for lab seizure information, variables on ecological, economic, demographic, and residential conditions in the lab seizure counties were extracted from the *County-City Data Book 2000* (U.S. Department of Commerce 2003) and from the *County Characteristics, 2000-2007* data file distributed by the Inter-University Consortium for Political and Social Research (ICPSR 2007). County-level crime and arrest rate data were obtained from the *Uniform Crime Reporting Data* for 2003, 2004, and 2005 and were averaged across those three years (FBI 2005; 2006; 2007). Information on presence of prisons or state correctional institutions in counties was obtained from the American Correctional Association's *Directory of Juvenile and Adult Institutions* (ACA 2000). Dates when state-level precursor regulations took effect were obtained from the National Association of Chain Drug Stores website (NACDS 2008). Data on county-level church attendance rates were available from the Association of Religious Data Archive (ARDA 2002). Data on Indian Reservation locations in counties were obtained from the Census Bureau's *Boundary and Annexation Survey* for 2006 (Census Bureau 2006). Presence of interstate highways in counties in 2000 was provided by Professors Tom Ricketts and Randy Randolph of University of North Carolina.

Analytical Strategies

While the problems of methamphetamine production are fairly widespread, they are not universal. Almost half (46.3%) of the counties in the United States reported <u>no</u> methamphetamine labs in the 4½ year interval between January 2004 and July 2008 according to the National Clandestine Lab Register (DEA 2009). And of counties reporting any lab seizures, the majority reported only a few (1 to 3 seizures) during this time frame. At the other extreme, a small fraction (about one-tenth of the counties who reported having any local meth labs) reported 20 or more lab seizures, and ten counties reported more than 100 meth labs seized during the period (up to 330 seizures reported in the most intensive county). Thus, the problem of local methamphetamine laboratory production, while widely found, is highly variable across states and across counties within states. Such variability raises several questions: What makes some communities more prone to methamphetamine lab problems than others? What have been the effects of increased precursor regulation by state and federal governments on the levels and patterns of local meth production?

At present there are no explicit theoretical models for predicting community-level patterns in methamphetamine production. A few theories (mostly derived from a Social Disorganization or Strain framework) have addressed the social distribution of drug use patterns; however, these do not deal with methamphetamine specifically (for which use or abuse patterns are generally quite different from other types of drugs) nor do they deal with the topic of drug production (which evinces very different social dynamics from the phenomenon of drug use). Most methamphetamine research is focused on individual users, behaviors, and treatment effects, with little attention to community-level patterns.

Rather than testing a specific theoretical model, the conceptual approach used here follows the analytical framework adopted by the Centers for Disease Control and Prevention (in U.S. Department of Health and Human Services) in their studies of violence, disease, and other health-related problems. Drawn from a variety of sources (e.g., Bronfenbrenner 1979; Dahlberg and Krug 2002; Garbarino 1978), this perspective is called the *Social-Ecological model*, but despite the label, it is not in itself a specific causal/predictive model of particular outcomes. Rather, it is a broad orientational framework to guide the study of and prevention of a wide variety of harmful social problems – including illness, disease, drugs, violence, and other illegal behaviors. According to this model, harmful social practices invariably entail complex social dynamics that must be addressed at a number of levels of analysis and studied in terms of many different causal factors operating cumulatively or interactively. This approach is avowedly inductive, theoretically non-partisan, and comprehensive (i.e., "casting a wide net" for theory and policy development), rather than parsimonious, theoretically-focused, and aimed at confirming or testing specific theoretical models.

This study is intended to fill in the gaps in empirical knowledge about the prevalence and patterning of methamphetamine lab problems in the United States, and it entails two distinct tasks. The first part of the analysis focuses on empirically documenting national and regional patterns of methamphetamine lab seizures, with special attention on the impact of stronger precursor regulations on the numbers of meth labs reported by police. The second part of the analysis is to identify those community-level variables most consistently predictive of meth lab seizures. In practical terms, this part of the analysis is aimed at identifying community risk factors for the presence of local methamphetamine labs.

Analysis began by identifying a wide range of plausible or potentially relevant community-level predictor variables for methamphetamine lab problems. These were drawn from various popular or journalistic accounts of local meth production processes (e.g., Owen 2007) and from analyses of community-based models of crime and drug problems more generally. In casting a wide exploratory net, 63 plausibly relevant variables were included in the data for this study (see Appendix A for a complete listing). For manageability, these were divided into four conceptual groups that served as heuristic themes for classifying the variables. These four groups are not presented as mutually exclusive or theoretically discrete categories, since some variables plausibly could be included in several categories. Our classification included:

1) *Ecological factors* (16 variables), that include both geographic attributes of the counties' locations (e.g., land area, inter-state highways, urban proximity) and demographic attributes of the counties' populations (e.g., population composition by race, population density; education levels);

2) *Economic factors* (20 variables), that include both the levels of economic activities or resources (e.g., income levels, poverty levels, and employment levels) and the characteristic <u>forms</u> of economic activities (e.g., manufacturing, farming, and service-sector employment);

3) *Subcultural/Lifestyle factors* (11 variables), that include religious and political values, degree of urbanism, levels of local crime and deviance within the communities. Church membership rates are included here as plausible indicators of the strength of community institutions of informal social control and community lifestyles. Separate measures of church membership rates in mainline denominations and evangelical denominations were also included, because models of community based on Civic Engagement or Social Capital theory have argued that mainline denominations will be more responsive to social problems in their community than will evangelical denominations (e.g., Lee 2006; Putnam 2000);

4) *Social Disorganization/Community Engagement factors* (16 variables), that include those factors seen as weakening or strengthening the social/institutional fabric of the community (e.g., population instability, ethnic heterogeneity, family disruption, political and civic participation).

The number of county-level variables from these sources is considerable – an analytic "embarrassment of riches." The analytical strategy applied here to bring some order to the inductive process is the Social-Ecological model used by the Centers for Disease Control and described above. Some predictor variables may be highly correlated with other variables that measure similar ideas (e.g., percent of population living below poverty level and median household income, r = -.79). To identify a parsimonious and nonredundant set of predictor variables while reducing the number of variables to a manageable size, the analysis of community-level predictors proceeded in several steps.

First, bivariate correlations were computed between all predictor variables and the dependent variable. Variables showing at least moderate correlations (r = .10

or larger) with lab seizure rates were retained, while those showing negligible associations were dropped from further consideration. Next, to eliminate redundant indicators of common or closely related constructs, multiple regressions were carried out within each of the four heuristic groups of variables, with lab seizure rates as the dependent variable and all predictor variables retained in the first step as the independent variables. Variables with standardized partial regression coefficients (betas) of at least .10 within each group were retained to reflect those variables with the largest unique predictive relationship to lab seizure rates while controlling for collinearities among similar indicators. Finally, a single overall multiple regression (with the logged county-level laboratory seizure rate as the dependent variable) was estimated using all variables in the four conceptual groupings retained in the first two data-reduction steps. This provides an omnibus identification of the individual risk factor variables most predictive of higher meth lab seizure rates to answer the following question. What are the specific social, economic, and ecological risk factors that characterize communities or areas where meth labs appear?

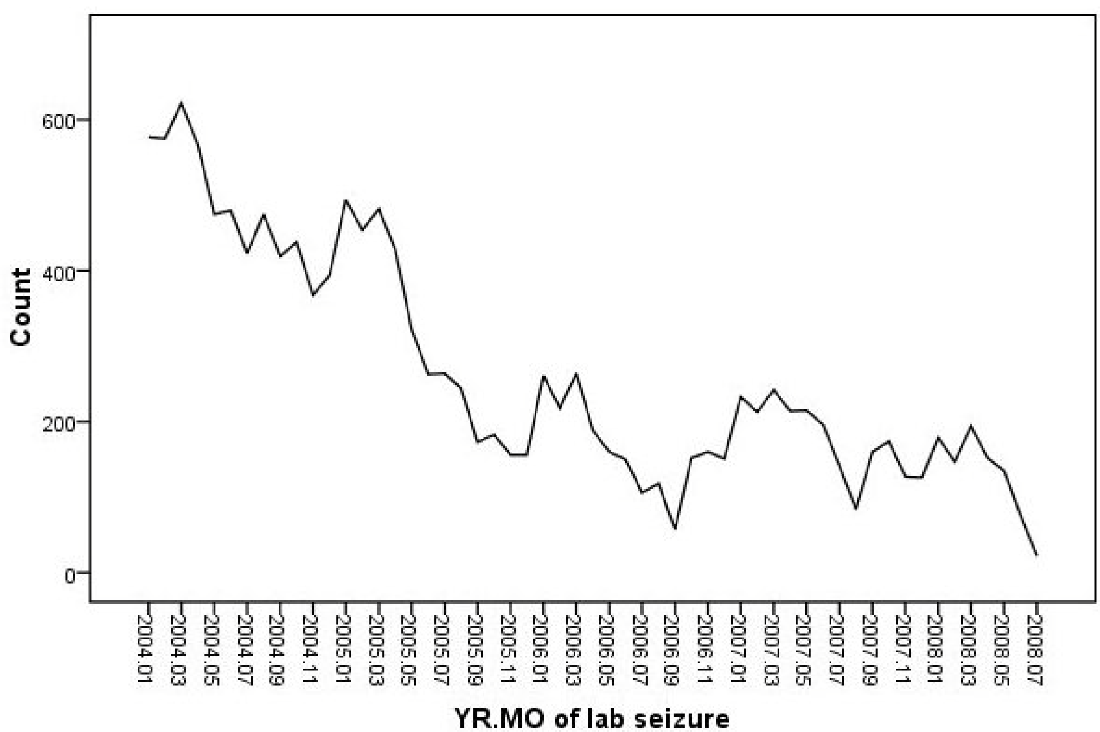
RESULTS

Laboratory seizure data allow for analysis down to the street level. However, other data of interest seldom allow for analysis at that level of detail. Also, aggregating up to the county, state, regional, and national levels provides a much more comprehensive picture of methamphetamine production. The discussion begins with an examination of national-level patterns and then moves to regional, state, and then county units of analysis, depending upon the variables under consideration.

National-Level Patterns

The number of laboratory seizures declined over the time period covered by these data. Figure 1 not only shows this decline but also indicates an interesting pattern. While the general trend is one of decline, there are several periods of rebound, and these periods follow a pattern. For each of the years under study, there is a small bounce-back followed by decline early in the year, around March. While the pattern is clear, the reasons for the pattern are not.

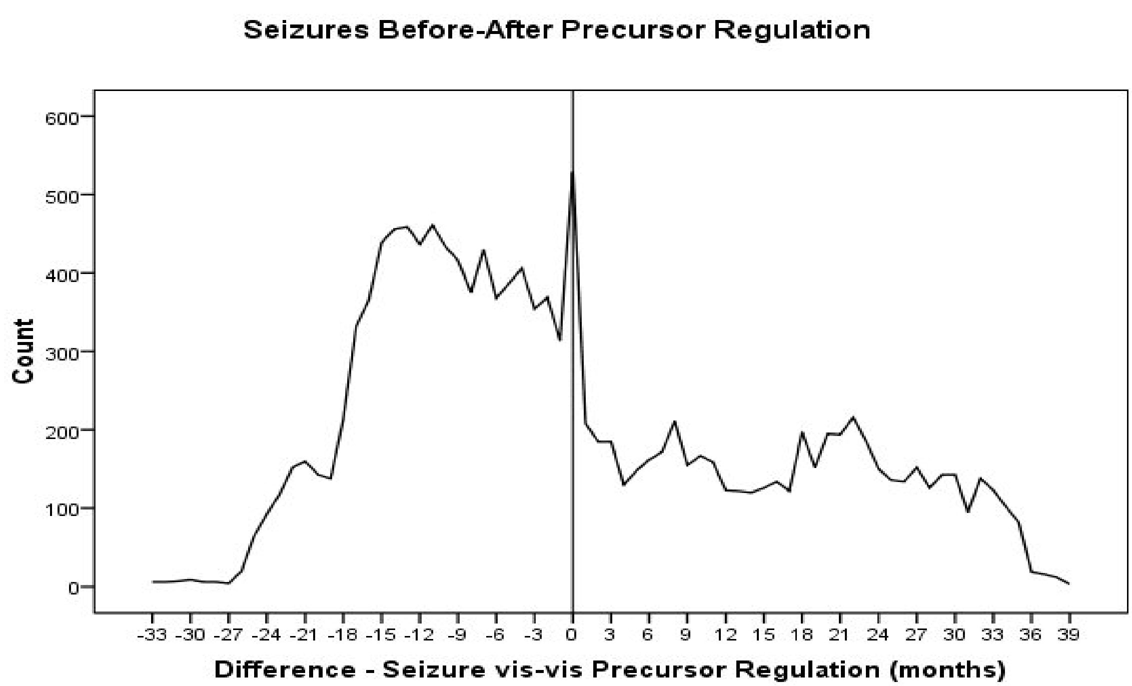
Figure 1. *Laboratory Seizures in the U.S. (2004-2008)*



N=14,448

Precursor laws. In an effort to stop domestic methamphetamine production, a number of states passed laws restricting access to over-the-counter medicines containing ephedrine, with most of these laws passed in 2005 and federal legislation becoming effective in March of 2006. When the federal precursor law went into effect, seven northeastern states had no state-level legislation and thus were regulated by the federal guideline. The empirical impact of precursor regulation is displayed in Figure 2, which shows the number of seizures in the months before and after state-level legislation, with numbers on the horizontal axis representing the time difference (in months) between date of each seizure and the date of precursor regulation in the state where the seizure was made. Negative numbers indicate seizures occurring prior to regulation while positive numbers denote seizures after state regulation was implemented. Where states had no laws (n=7) or where state law went into effect after federal law (n=12), the federal date was used as the effective onset of regulation. The graph line in Figure 2 shows a sharp drop in seizures in the months immediately following passage of the law, with two minor spikes 8 months following passage and again in the 18-23 month period after passage, with the figures dropping substantially after that. These results reveal a very pronounced "intervention effect" in which precursor regulations dramatically and immediately reduce the number meth labs found by police; this effect persists for at least three years following the intervention. This pattern represents a national pattern applying to all the regions of the U.S. and differs sharply from the negligible and short-lived intervention effects of precursor regulation reported in earlier studies of California data (Cunningham and Liu 2003, 2005; Dobkin and Nicosia 2009).

Figure 2. *Frequency of Lab Seizures Before-and-After State Precursor Regulations*



[(a)] *Negative* numbers represent occurrence of Lab Seizures before State Regulation of Precursors was implemented in that state; *positive* numbers represent lab seizures occurring after state regulation of precursors. All states whose precursor regulations were passed after federal implementation of precursor regulation were assigned the date of the federal precursor law (rather the date of their own post-federal implementations).

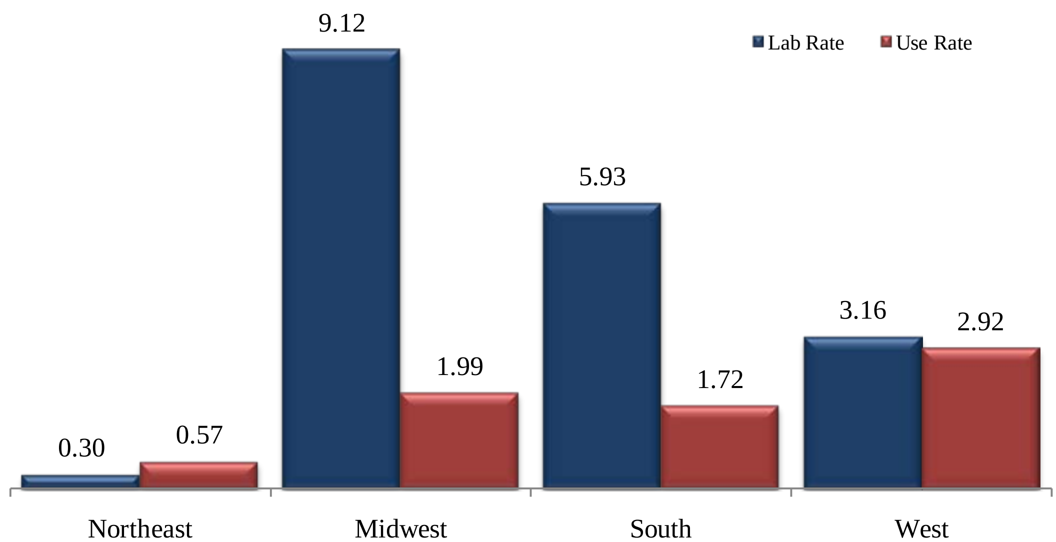
[(b)] California cases have been excluded from this graph, due to the uncommonly early implementation of the California regulation, which means that all California cases are necessarily post-regulation due to data set limitations. Arkansas was the next state to implement regulations in March of 2005.

Several additional things about Figure 2 are worth mentioning. First is that lab seizures had begun to decline about a year before the laws went into effect, reflecting perhaps aggressive enforcement, public education, and/or the drug undergoing a natural cycle of decline. Second is the sharp upward spike that corresponds precisely with the passage of state regulations in the month before their implementations. The reasons for this are unclear, but it may be that meth cooks were particularly active in securing precursors in advance of restrictions, and this heightened activity drew the attention of authorities. Third is that while seizure levels dropped noticeably after restrictive laws were passed, they were still relatively high for several years following legislation. These findings are particularly interesting in light of recent reports from some Midwestern states that the number of laboratory seizures in the first half of 2008 have exceeded the numbers for all of 2007 (Bauer 2008; Halladay 2008; Huchel 2008), a pattern not seen in our national level data. Figure 2 suggests that efforts to curb access to precursors have had an impact on domestic methamphetamine production, suppressing it but not eliminating it.

Regional-Level Patterns

Methamphetamine use and production first began at high levels in the West and from there spread eastward. Consequently, it is expected there will be regional variations in the extent to which laboratories have been seized. Figure 3 shows that laboratory seizures are not evenly spread throughout the U.S. but are most heavily concentrated in the Midwest and South. If measured by laboratory seizures, methamphetamine production has almost no foothold in the Northeast, which accounts for 19 percent of the country's population but only 1 percent of the meth lab seizures (164 seizures out of 14,448 nationwide). The smaller proportion of seizures in the West, when compared with the Midwest and South, might be accounted for by the influx of methamphetamine from Mexico, replacing domestic manufacturing in that region. Unfortunately, laboratory seizure data do not go far enough back in time to test this idea. It is possible, however, to compare regional variations in laboratory seizures with regional variations in self-reported methamphetamine use by drawing on data from the National Survey on Drug Use and Health. These data show that while the seizure rate in the West is about half that of the Midwest and South, self-reported use rates are about 50 percent higher in the West than in the Midwest or South. This is consistent with the idea that domestically

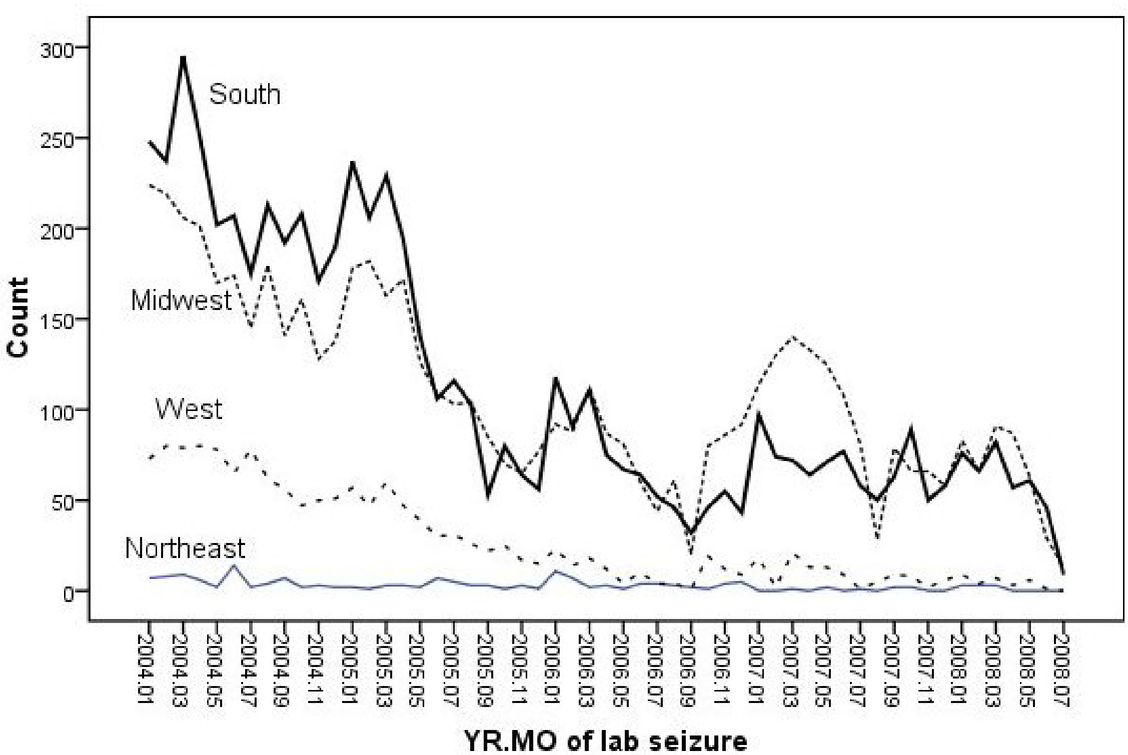
Figure 3. *Methamphetamine Laboratory Seizure Rates and Use Rates*



produced methamphetamine is being replaced by methamphetamine imported from Mexico in the West, and/or that in the West numerous small laboratories have been replaced by a smaller number of super labs.

An examination of when laboratory seizures occurred can also illustrate regional variations in the introduction of methamphetamine production. Figure 4 shows the pattern of methamphetamine laboratory seizures for each of the four major regions in the U.S. As the figure reveals, the highest rates and the most dramatic reductions in seizures are in the South and Midwest. The Northeast, where relatively few labs had been found, shows almost no change over time. Unexpectedly, laboratory seizures in the Midwest were actually more frequent one year after federal precursor legislation than in 2006 when that legislation took effect. Further, the general pattern of decline is similar in the South, Midwest, and West. Most striking about these regional trends is the extent to which the patterns of peaks and valleys are similar across regions.

Figure 4. *Region Trends in Lab Seizures*



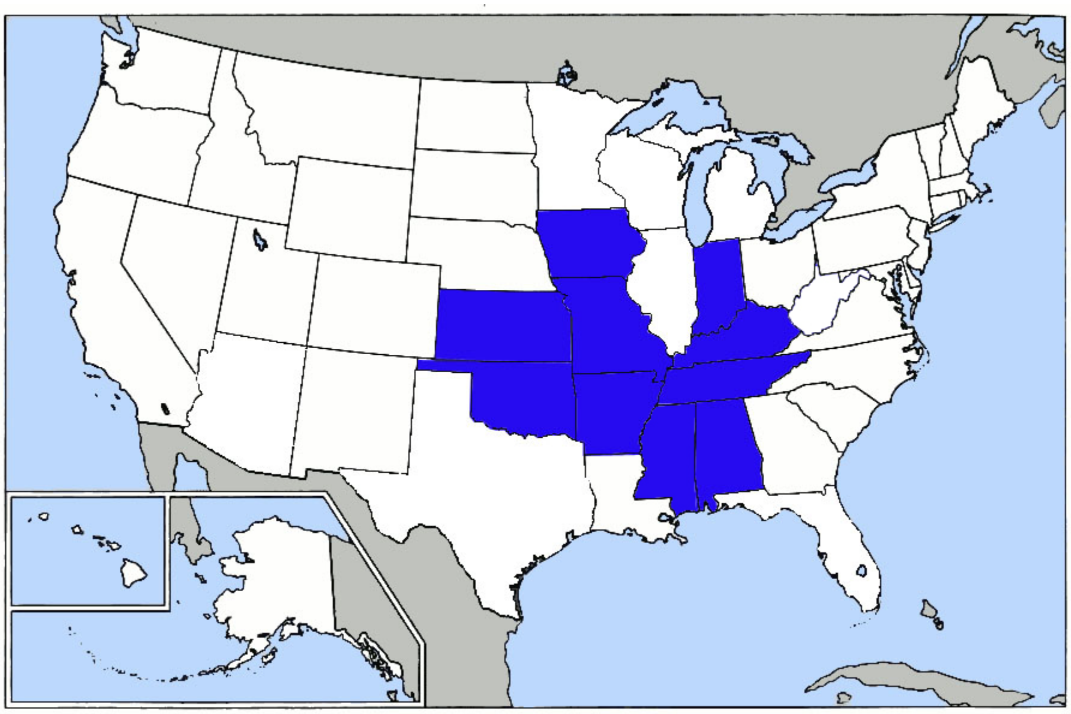
N = 14,448

State-Level Patterns

An analysis of state-level patterns of laboratory seizures reflects the prominence of the Midwest and South as locales for methamphetamine production. Table 1 and Figure 5 both show the ten states with the highest laboratory seizure rates. The table shows that the states with the highest seizure rates are all in the Midwest and South, and several of those in the south border the Midwest. It is also interesting that the top ten states for laboratory seizures are contiguous. That is, there are no states in the top ten that do not touch at least one other state in the top ten.

Table 1. *Top States for Lab Seizures 2004-2008*	
State	**Seizure Rate***
Missouri	37.16
Arkansas	32.54
Iowa	19.30
Tennessee	17.38
Indiana	15.64
Kentucky	15.24
Alabama	13.32
Oklahoma	11.61
Kansas	10.86
Mississippi	10.72
*Rate per 100,000 people.	

Figure 5. *Ten States with the Highest Seizure Rate per 100,000 People*



It is possible to aggregate methamphetamine laboratory seizure data at the state level and compare the seizure rate (per 100,000 people) with the reported rate of methamphetamine use in the past year by those ages 12 and over, as reported by the National Survey on Drug Use and Health. At the state level, the association between laboratory seizure rates and methamphetamine use rates is substantial (r = .39) but far from determinate. This suggests that while local use and production of methamphetamine are related, they represent rather distinct social processes and that models describing the geography of drug use may be of limited use in explaining the differential distribution of laboratory seizures.

County-Level Patterns

While it is useful to know national, regional, and state variations, analyses at these levels may mask important local variations. It is at the county level that we have the richest variety of data that can be combined with seizure data, and at which one might expect the most valid picture of the issue. The specific dependent variable used in the county-level analysis and comparisons was the *logged lab seizure rate* for each county – computed as the natural logarithm of the ratio of number of lab seizures reported in each county during the 2004-2008 data period divided by the census estimated population of the county in 2005. (A constant of 1.0 was added to the seizures/population ratio before taking its logarithm to insure that zero scores would be equal to zero seizures.) Using seizure rates, rather than counts, controls for the large effect of population size on incident counts and allows for direct comparisons between counties of widely different population sizes. Using the logarithm of the seizure rate (rather than the unmodified rate) is a common transformation for a highly skewed variable, providing a dependent measure that is much more uniformly distributed and less affected by a few extremely large values. However, even with the log-transformation, one distributional anomaly remains: namely, the unusually high proportion of cases with a value of zero (the 46% of the counties who reported no lab seizures between 2004 and 2008). This results in a zero-inflated or "left-censored" dependent variable for which ordinary statistical estimates may be less suitable or biased. To assess this possibility, we duplicated all the multiple regression estimations in the analysis using Tobit analysis (a statistical variant of ordinary linear regression usable with censored dependent variables). The additional Tobit analyses simply confirmed and duplicated the findings reported with ordinary least square regression, yielding the same pattern of significant and insignificant variables as well as comparable levels of R^2. In this paper, we report only the ordinary regression results here, in the interest of greater familiarity and readability of findings.

Our attention turns first to the impact of precursor regulations at the county level. An examination of these data finds that while 43.8 percent (n=1,351) of the counties reported labs before precursor restrictions went into place, more than one third of the counties (1,123 of 3,083 or 36.4%) reported labs after these laws took effect (See Table 2). This suggests the problem persists to a considerable extent. The impact of precursor regulation can also be seen by considering whether counties reported meth labs before and after the passage of precursor regulations. Table 2 shows that of the 1,351 counties reporting meth labs before these laws took effect, more than half (61.6%) still reported labs after these laws were in place. Further, of those 1,732 counties reporting no methamphetamine labs before precursor regulations took effect, 291 (16.8%) reported meth labs after precursor regulations went into effect.

Table 2. *Counties Reporting Meth Lab Seizures Before and After Precursor Regulations*

	Lab Seizures Before Regulation		
Lab Seizures After Regulation	Yes	No	Total
Yes	832 (61.6%)	291 (16.8%)	1123
No	519 (38.4%)	1441 (83.2%)	1960
	1351 (100.0%)	1732 (100.0%)	3083

Note: All 58 California counties are excluded because of the uncommonly early implementation of the California regulation (January 1, 2000), which means that all California cases are necessarily post-regulation.

MULTI-VARIATE ANALYSIS

Following the data-reduction steps outlined earlier yielded a final set of 20 independent (predictor) variables at least moderately correlated with meth lab seizure rates. These variables were entered into a single overall multiple regression equation with the (logged) laboratory seizure rate as the dependent variable. The regression results are displayed in Table 3, which reports the partial regression coefficients (both standardized and unstandardized) along with accompanying statistical information (standard errors, t-statistics, and p-levels). For purposes of this analysis, the important information in Table 3 is contained in the column of standardized regression coefficients (labeled **β**), which allow a comparison of the different variables all expressed in the same metric (standard deviation units). Also, because the data set effectively includes the population (of all counties in the U.S.) rather than a sample, the number of coefficients estimated from the data is fairly large, and the number of cases used in the regression is large (N = 2,455), analysis of results relied on substantive criteria of "significant associations" rather than

Table 3. *Regression of the Logged Meth Lab Seizure Rates on Final Subset of Variables*

Variables	**b**	**S.E.**	**β**	**T**	**P**
Economic Variables					
Manufacturing as % of All Employment	.026	.004	**.141**	7.04	<.001
Per Capita Income (in $1000s)	-. 012	.006	**-.051**	-2.02	.044
Ecological/Population Variables					
% Speaking Foreign Language in Home	-.028	.004	**-.197**	-7.80	<.001
% White in Population	.019	.007	**.196**	2.90	.004
% of Adults with a High School Degree or More	-.003	.007	**-.015**	-.040	.688
% of Population Under Age 18	-.004	.012	**-.008**	-0.35	.728
Subcultural/Lifestyle Variables					
% of Congregations That Are Evangelical	.014	.002	**.195**	7.48	<.001
Disorderly Conduct Arrest Rate (per 1000)	-.068	.011	**-.115**	-6.07	<.001
Property Crime Rate (per 1000)	.010	.003	**.104**	3.88	<.001
Violent Crime Rate (per 1000)	.021	.016	**.033**	1.27	.205
Dissimilarity Index (Black-White by residence)	.005	.002	**.045**	2.41	.016
Social Disorganization/Civic Engagement Variables					
% of Population that is Farm Population	.035	.006	**.161**	6.00	<.001
% Single Female-Headed Family Households	.035	.014	**.132**	2.41	.016
% Moved into Household in Last Year	.040	.016	**.122**	2.42	.015
Racial Diversity Index	-.888	.397	**-.117**	-2.24	.025
% Housing that is Occupied (vs. Unoccupied)	.017	.003	**.108**	4.99	<.001
% of Housing that is Owner-Occupied	.016	.007	**.079**	2.19	.029
% of Eligible Voter who Voted in 2004	-.011	.005	**-.064**	-2.13	.033
Population Change from 2000 to 2005	-.012	.005	**-.055**	-2.17	.030
% Lived in Different House in 1995	.010	.010	**.051**	0.99	.319
Overall R^2 = .248; N = 2,455					

conventional null-hypothesis-testing criteria. For our purposes, a variable was considered to have a significant predictive relationship with the lab seizure rates when its **β**-coefficient was .10 or greater.

As Table 3 shows, nine of these variables were no longer substantively significant when entered as part of the group. Among *economic factors* variables, only the presence of manufacturing jobs was significant, and among *ecological factors*, only speaking a foreign language in the home (negative association) and the percent of the population that was White were significant. Among *subcultural/lifestyle* factors, there was a positive association between lab seizure rates and the rate of property crime and between seizure rates and the presence of evangelical churches. However, arrest rates for disorderly conduct were significantly but negatively associated with lab seizures – i.e., higher arrests rates with lower lab seizure rates. Finally, there were five variables from the *social disorganization/civic engagement* factor that were associated with lab seizure rates. There was a positive association between the lab seizure rate and the percent of the population living on farms, the rate of female-headed family households, the percent of households who had moved within the past year, and the percent of the housing units that were occupied. The laboratory seizure rate was negatively associated with the county's racial diversity. That is, lab seizures were more prevalent in those counties with the least racial diversity (i.e., most uniformly nonminority). All together, these variables accounted for 25 percent of the variance in laboratory seizure rates across U.S. counties.

DISCUSSION

Most illicit drugs present two serious problems for society. First are the many consequences of drug use for the user, the community, and society as a whole. Second is the violence that accompanies the business of drugs that are transported across national borders through elaborate networks. Methamphetamine contributes to both problems, but in many parts of the country it presents another serious problem, namely the social and environmental damage that comes from domestic methamphetamine production. This study has focused on geographic patterns of production and correlates of the patterns associated with this latter problem.

Overall, these results confirmed that the distribution of methamphetamine laboratories is not random and displays notable regional variation. While use is most prevalent in the West, laboratories are more likely to be seized in the Midwest and South. The results also provide notable and robust evidence that legal regulations to restrict access to precursors, particularly ephedrine-based products, have reduced substantially the number of local domestic meth labs (contrary to the findings of earlier studies in California), but has not ended domestic production.

The multivariate analysis of county-level correlates of meth lab seizures also proved revealing. The summary picture from these results is that local methamphetamine labs are more likely to be reported by police in counties or areas with rather different characteristics from typical drug problem communities. For one thing, *economic disability*, which figures very prominently in most theories or models of crime and drug problems, was not a prominent factor in predicting communities with more meth lab incidents. Unemployment rates and poverty levels were negligibly correlated with meth lab rates; personal and household income levels showed slight negative bivariate correlations with meth lab seizures, but these variables dropped out in the multivariate analysis. The only persistent economic variable to predict meth lab prevalence was the predominance of manufacturing in the county's employment profile: namely, higher percentages of manufacturing employment correlated with higher rates of meth lab seizures. Beyond this, economic variables were surprisingly absent from the final list of significant predictors of meth lab incidents.

In terms of *ecological factors*, spatial or geographic variables all proved unimportant in explaining or predicting counties with meth lab problems. Despite their intuitive plausibility, such factors as land area, population density, interstate highways, and natural scenic resources were negligible predictors of which counties had meth lab seizures. Only the demographic population composition variables were consistently correlated with and predictive of meth lab seizure rates; and here the empirical patterns were dramatically different from the demographic patterns normally associated with higher drug problems. Notably, counties with high rates of meth lab seizures tend to be racially homogeneous populations of largely white, native-born residents. In contrast, racial heterogeneity and higher percentages of foreign-born, non-English-speaking residents were noticeably correlated with lower rates of meth lab incidents across counties. The larger the proportion of racial minorities and the greater the mixture of ethnic groups in the county population, the lower the prevalence of meth labs. This is consistent with reported patterns of methamphetamine user characteristics, who are predominantly white (Weisheit and White 2009).

Regarding *subcultural/lifestyle* factors, property crime rates, arrest rates for disorderly conduct, and the percent of churches that are evangelical were significant predictors of laboratory seizures. However, violent crime rates and racial residential segregation measures (Black-White dissimilarity index) were not associated with the number of labs seized. It may seem paradoxical that one of the strongest, most consistent correlates of meth lab prevalence is prevalence of evangelical churches in counties, either in terms of membership rates in evangelical churches or percentages of evangelical congregations among county churches. This finding is not predicted by any conventional theory of drug use or production, but it is predicted by recent versions of Social Capital theory, arguing that different kinds of church memberships reflect different kinds of social bonds and have different aggregate effects on the community-level exercise of social control. Thus, the finding is consistent with some prior research on community-level crime patterns (Lee 2006, 2008) and not as anomalous as it might appear. To be clear, this aggregate level analysis applies only to county-level patterns and does not suggest that members of evangelical churches are more heavily involved in the manufacture of methamphetamine.

Overall, the conceptual frameworks of *social disorganization* and *civic engagement* do not provide consistent predictions of meth lab problems. Contradictory to basic social disorganization premises, racial diversity and low household occupancy rates are negatively correlated with meth lab problems, while economic disadvantage and long-term population change are negligibly correlated with meth lab seizures. Of social disorganization indicators, only community rates of family disorganization (e.g., percentages of singe-female-headed family households) or short-term population transience (i.e., immigration within the past year) were positively correlated with meth lab problems. On the whole, classical social disorganization theory does not predict meth lab seizures in counties. The results were similarly mixed and occasionally contradictory for civic engagement theory, which predicts lower rates of crime and social problems in communities which have higher rates of voluntary association, civic participation, farm-based population, and local small-scale capitalism. Overall rates of church membership or of voter election participation (both posited as key indicators of civic engagement) were essentially uncorrelated with meth lab rates. In contrast, some other components of civic engagement – such as percent of the population living on farms, percent of residents owning their own homes, or percent of labor force that is self-employed – were correlated with lab seizure rates in directions opposite to the predictions of civic engagement theory.

In sum, the counties with the highest rates of meth lab seizures by police are counties with homogeneously white, native-born, stable populations with higher levels of persons employed in manufacturing, living outside urban areas, and belonging to evangelical churches.

While precursor regulations have noticeably reduced the number of meth labs discovered by police, there is no evidence that the problem of domestic methamphetamine production will go away soon. In fact, while the number of laboratories seized by the police went down after restrictions were placed on the purchase of ephedrine-based cold medicines, nationally the numbers are now growing (National Drug Intelligence Center 2010). Controlling the problem is important because it has implications for the environment and for innocent people exposed to chemical residue from these labs.

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***Appendix A**. Social and Economic Variables by Theoretical Framework*

Economic Factors

*Per Capita Personal Income
*Median Household Income
*Social Security Beneficiaries, Rate Per 1,000
*Manufacturing Employment as % of all Employment
*Percent of Personal Earnings from Manufacturing
*Percent of Total Earnings that are Farm Earnings
*Farming-Dependent County (dichotomy – ERS typology)
*Manufacturing-Dependent County (dichotomy – ERS typology)
*Housing-Stressed County (dichotomy – ERS typology)
Percent of People of All Ages Below the Poverty Level
Unemployment Rate
Farm Employment as Percent of All Employment
Retail Employment as Percent of All Employment
Service Sector Employment as Percent of All Employment
Percent Change in Median Household Income from 2000-2003
Low-Education County (>25% of adults w/out a high school equivalent) (dichotomy – ERS typology)
Low-Employment County (<65% of adults employed) (dichotomy – ERS typology)
Persistent Poverty County (>20% in poverty in 1980, 1990 & 2000) (dichotomy–ERS typology)
Population Loss County (population decline from 1980-2000) (dichotomy – ERS)
Retirement Destination County (dichotomy – ERS typology)

Ecological Factors (Geographic and Demographic)

*Regional dichotomies (Midwest, South, West, Northeast)
*Natural Amenity Scale
*Percent of Population = White
*Percent of Population = Foreign-born
*Percent of Population = Young (under 18 years old)
*Percent of Population with High School Education or higher
*Speaking a Foreign Language in the Home
Urban Influence Scale
Presence of Interstate Highway (dichotomy)
Presence of Prisons (dichotomy)
Population Density
Land area (of county)
Percent Commuting Outside County to Work
Percent of Population = Hispanic
Percent of Population = Elderly (65 years old and older)
Racial Segregation by Residence (Dissimilarity Index)

Subcultural/Lifestyle Factors

*Disorderly Conduct Arrest Rate
*Rate of Membership in Evangelical Congregations per 1,000
*Percent of Congregations that are Evangelical
*Dissimilarity Index (segregation of Blacks and Whites within county)
Property Crime Rate
Violent Crime Rate

Drug Arrest Rate DUI Arrest Rate Offenses Against Family Arrest Rate Percent Voting Republican in 2004 Presidential Election Rate of Membership in All Churches (& Synagogues) per 1,000
Social Disorganization/Civic Engagement Factors *Percent of Housing Units = Occupied *Percent of Housing Units = Owner-occupied *Racial Diversity (Heterogeneity Index) Percent Population change 1900-2000 Percent Population change 2000-2005 Percent of foreign in-migration in past year Percent of resident born in the state Percent of residents who moved in last year Percent of residents who lived in different house 10 years ago Percent of single female-headed family households Voter Participation Rate (eligible adults who voted in 2004 election) Rate of Membership in Mainline Denomination churches per 1,000 Percent of the county population = farm population Percent of farms = small (less than 50 acres) Percent of farms = large (greater than 500 acres) Percent of employment = self-owned
Note: This appendix provides a listing of all variables initially considered in the analysis. Those variables preceded by an asterisk (*) are variables that have a significant bivariate correlation with the county's rate of laboratory seizures. Other variables are either not correlated with the rate of seizures or are highly correlated with one of the marked variables and thus are redundant with that variable.

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