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ABSTRACT

Political and economic transition is often blamed for Russia's 40% surge in deaths between 1990 and 1994. Highlighting that increases in mortality occurred primarily among alcohol-related causes and among working-age men (the heaviest drinkers), this paper investigates an alternative explanation: the demise of the 1985-1988 Gorbachev Anti-Alcohol Campaign. Using archival sources to build a new oblast-year data set spanning 1978-2000, we find a variety of evidence suggesting that the campaign's end explains a large share of the mortality crisis – implying that Russia's transition to capitalism and democracy was not as lethal as commonly suggested.

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Crude death rates in Russia soared by 40% between 1990 and 1994, climbing from 11 to nearly 15.5 per thousand.[1] By 2009 standards, the decline in male life expectancy at birth (by nearly 7 years, to 57.6) would tie Russian men with their counterparts in Bangladesh, falling short of male longevity in less-developed countries with troubled population health histories (Botswana, Haiti, North Korea, and Yemen, for example). The magnitude of this surge in deaths – coupled with the Soviet Union's international prominence – has prompted observers to term this demographic catastrophe "the Russian Mortality Crisis."

The underlying cause of the mortality crisis has been hotly debated, but most accounts implicate Russia's political and economic transition.[2] Specific transition-related explanations include: a decline in economic output and employment (Cornia and Paniccia 2000; Brainerd 2001), rapid privatization (Stuckler, King, and McKee 2009; Stuckler, King, and McKee 2012), physiological and psychological stress (Shapiro 1995; Bobak and Marmot 1996; Kennedy, Kawachi, and Brainerd 1998; Leon and Shkolnikov 1998; Gavrilova et al. 2001), rising inequality (Lynch, Smith, Kaplan, and House 2000; Denisova 2010), reductions in the relative price of vodka (Treisman 2010), and deterioration of the medical care system (Ellman 1994).[3]

The proximate cause of the crisis is less controversial: alcohol consumption soared in Russia between 1990 and 1993 (Leon et al. 1997; Treml 1997;

[1] Throughout this paper we use the term "Russia" to refer to the Russian state of the Soviet Union (until December 1991) and the Russian Federation (after December 1991).
[2] In response to Stuckler, King, and McKee's (2009) article in *The Lancet* suggesting that privatization was responsible, see Jeffrey Sachs' rebuttal in the *Financial Times* on January 19, 2009 ("Shock Therapy' Had No Adverse Effect on Life Expectancy in Eastern Europe"), the subsequent reply by the authors in the *Financial Times* on January 22, 2009 ("Rapid Privatisation Worsened Unemployment and Death Rates"), and a recapitulation in *The Economist* on January 22, 2009 ("Mass Murder and the Market"). See also re-analyses by Earle and Gehlbach (2010) and Gerry, Mickiewicz and Nikoloski (2010).
[3] Brainerd and Cutler (2005) provide a thorough review of this literature.

Shkolnikov et al. 1998; Walberg et al. 1998).[4] The types of deaths that increased most during the transition were related to alcohol, either directly (alcohol poisonings and violent deaths) or indirectly (heart attacks and strokes) (Leon et al. 1997; Gavrilova et al. 2000; Brainerd and Cutler 2005). Although most diseases disproportionately kill the young and the old, crisis deaths were also concentrated among working age men – the demographic group that drinks the most.[5]

Recognizing the central role of alcohol, we investigate an alternative explanation for the Russian mortality crisis. Rather than the transition to capitalism and democracy, we study the coincident demise of the (reputedly successful) 1985-1988 Gorbachev Anti-Alcohol Campaign (Leon et al. 1997; Shkolnikov and Nemtsov 1997; Cockerham 1999). The campaign was unprecedented in scale and scope – and it operated through both supply- and demand-side channels, simultaneously raising the effective price of drinking and subsidizing substitutes for alcohol consumption. At the height of the campaign, official alcohol sales had fallen by as much as two-thirds (Russians responded by increasing home-production of alcohol called *samogon* – although our estimates suggest not by nearly enough to offset the reduction in state supply).[6] In practice the campaign lasted beyond its official end– restarting state alcohol production required time, and elevated alcohol prices lingered.

Figures 1a and 1b depict our basic logic (Human Mortality Database 2011). Both crude (Figure 1a) and age-adjusted (Figure 1b) Russian death rates increased linearly between 1960 and 1984, plummeted abruptly with the start of the campaign in 1985, remained below the pre-campaign trend throughout the latter 1980s, rose rapidly during the early 1990s to a temporary peak in 1994, and then

[4] Exceptions are Bobak et al. (1999) and Bobak and Marmot (1999), who use survey data to question the role of alcohol consumption in explaining the mortality crisis.
[5] Death rates among males ages 35-44 rose by 74% between 1989 and 1994, for example.
[6] Throughout the paper, we use the term "*samogon*" to mean illegal alcohol generally.

largely reverted back to Russia's long-run trend.[7] The crisis could therefore be the combined result of lagged 'catch-up' mortality (as relatively weak marginal survivors saved by the campaign die at higher rates) together with reversion to the long-run trend. A lagged effect of alcohol consumption on mortality is consistent with findings in the medical literature on the delayed effects of alcoholism on both liver cirrhosis and heart disease (see, for instance, Holder and Parker 1992; Laonigro et al. 2009; and Savolainen, Penttila and Karhunen 1992). We develop additional evidence on this point in the appendix using data from the Framingham Heart Study.

[Insert Figures 1a and 1b Here]

We begin by establishing the association between the Gorbachev Anti-Alcohol Campaign and Russian mortality during the latter 1980s.[8] Because adequate sub-national data has not previously been compiled, doing so requires digitizing and harmonizing archival Russian data sources to create a new panel data set of Russian oblasts spanning years 1970-2000.[9] Our reduced-form approach then flexibly traces-out oblast-level changes in alcohol consumption and mortality over time which vary in proportion to pre-campaign alcohol consumption. This approach allows the data to tell us, in a flexible way, the lagged effects of the campaign and its end on Russian mortality.

Because the campaign was highly multifaceted and adequate data on its individual components are largely unavailable, we use pre-campaign alcohol consumption interacted with year dummies as a summary measure of campaign intensity (assuming areas with greater pre-campaign alcohol consumption to be

[7] Population aging appears to explain some but not all of the long-term upward trend in mortality in Figure 1A.
[8] This relationship has previously been studied only qualitatively or using aggregate national-level data – see White (1996), Treml (1997), Avdeev et al. (1998), and Nemtsov (2000). Balan-Cohen (2007) finds superior health indicators among children born during the campaign.
[9] Oblasts are Russian administrative units; Data available online.

disproportionately affected – following Bleakley (2007) and (2010), Qian (2008), Miller and Urdinola (2010), and Nunn and Qian (2011), for example).[10] Overall, we find that the campaign is associated with about 400,000 fewer deaths per year, a reduction of 24% relative to the pre-campaign crude death rate.

We then extend our framework to study the link between the end of the Anti-Alcohol Campaign and Russia's transition-era mortality crisis. Harder-drinking oblasts prior to the campaign not only experienced larger mortality declines during the late 1980s, but they also experienced disproportionate increases in deaths during the 1990s. This relationship peaked in the middle of the decade and matches temporal patterns predicted by independent simulations.[11] Causes of death more closely related to alcohol consumption (circulatory disease, accidents and violence, and alcohol poisoning) also increased relatively more in these oblasts during the 1990s. Importantly, these relationships are robust to – and in some cases are in fact strengthened by – controlling for local economic conditions during the transition period (GDP per capita, the employment rate, and employment in private manufacturing – a measure of privatization). All in all, our estimates explain a large share of the Russian mortality crisis.

We conclude by conducting complementary simulation analyses of the temporal relationship between alcohol consumption and survival (using the longest-running panel survey of drinking and mortality of which we are aware – the Framingham Heart Study) and documenting patterns of mortality commensurate with campaign exposure in other former Soviet States and Eastern European countries. On the latter, former Soviet states in the West and in the Baltics exhibit similar mortality declines during the late 1980s followed by

[10] Bleakley (2007) and (2010), Qian (2008), Miller and Urdinola (2010), and Nunn and Qian (2011) study population-wide health programs and interventions by assuming that areas with greater pre-campaign exposure to a disease agent or risk-factor benefitted disproportionately.
[11] Using Framingham Heart Study data, we find temporal relationships that are consistent with the pattern of mortality over time that we observe following the end of the anti-alcohol campaign (see Appendix 3).

similar surges during the early 1990s. This pattern is also present – but attenuated – in former Soviet states with large Muslim populations for whom alcohol policy matters less (in the Caucuses and Central Asia). By contrast, mortality patterns in Eastern European countries undergoing political and economic transitions but not subjected to the campaign (the Czech Republic, Hungary, Poland, and the Slovak Republic) are starkly different. These cross-national patterns are consistent with the demise of the Gorbachev Anti-Alcohol campaign playing an important role in the Russian Mortality Crisis. Taken together, our results suggest that Russia's transition to capitalism and democracy *per se* was not as lethal as often suggested.

I. Drinking in Russia and the Gorbachev Anti-Alcohol Campaign

A. *Alcohol Consumption in the Soviet Union and the Russian Federation*

The Soviet Union – and Russia in particular – historically ranks among the world's heaviest drinking countries. Alcohol consumption rose steadily between 1950 and 1985 – between 1960 and 1979 alone, alcohol sales nearly quadrupled (with disposable household income spent on alcohol reaching 15-20%) (Treml 1982; Segal 1990; Tarschys 1993; White 1996; McKee 1999). Just prior to the anti-alcohol campaign, annual consumption of pure alcohol in the Soviet Union exceeded 14 liters per capita (compared to 8 liters in the United States) (Nemtsov 2000). This figure is roughly equivalent to adult males consuming half a liter of vodka every two days (Ryan 1995).[12] Given lower levels of drinking in Soviet states with more Muslims (in the Caucasus and Central Asia, for example), the

[12] In addition to the quantity consumed, the type and pattern of alcohol consumption in Russia (compared to other heavy-drinking countries like France) has important implications for mortality. A disproportionate amount of consumption can be characterized as 'binge drinking' (defined as three or more measures of alcohol within 1 to 2 hours), especially on weekends and holidays (Bobak et al. 1999; Chenet et al. 1998; Malyutina et al. 2001; McKee and Britton 1998). Alcohol abuse and binge drinking are linked not only to accidents and violent deaths, but more quantitatively important, they are key risk factors for heart attacks and cardiovascular disease (McKee and Britton 1998; McKee, Shkolnikov and Leon 2001; O'Keefe, Bybee and Lavie 2007; Rehm et al. 2009;Tolstrup et al. 2006). Recent estimates suggest that alcohol abuse is responsible for more than half of all deaths in Russian cities among those ages 15-54 (Leon et al. 2007; Zaridze et. al. 2009).

counterbalancing rate for Russia alone was presumably much higher (Shkolnikov and Nemtsov 1997).

B. *The Gorbachev Anti-Alcohol Campaign*

By the early 1980s, alcohol abuse was widely recognized as a major cause of death, absenteeism, and low labor productivity in the Soviet Union.[13] Although difficult to estimate, observers suggest that alcohol's cost to the Soviet economy during the 1980s totaled about 10% of national income (Treml 1987; Segal 1990; Tarschys 1993; White 1996).

In response, the Politburo and the Central Committee passed resolutions entitled "Measures to Overcome Drunkenness and Alcoholism" in May of 1985 (shortly after Mikhail Gorbachev became Secretary General). These decrees and subsequent directives of the Central Committee and the Presidium of the Supreme Soviet ushered in the country's most stringent anti-alcohol policies since its 1919-1925 prohibition. Given tight state control of social and economic affairs, rapid implementation and rigid adherence to campaign mandates were possible.

The Gorbachev Anti-Alcohol Campaign consisted of seven broad measures designed to raise the effective price of drinking and subsidize substitute activities. Four were clearly supply-oriented. First, state production of alcohol was drastically reduced. Between June 1985 and May 1986 alone, state production of vodka and hard liquor declined by 30-40% (Segal 1990) and cognac production fell by 44% (White 1996). Second, substantial new restrictions were placed on alcohol sales. Liquor stores were not allowed to sell vodka or wine before 2pm on business days, restaurants were no longer permitted to sell hard liquor, and the official drinking age rose from 18 to 21. Sales near factories, educational institutions, hospitals, and airports were prohibited. Third, the government

[13] Alcohol played a central role in violent crimes and traffic accidents as well. According to then Interior Minister Vitalii Fedorchuk, two-thirds of all murder, battery, and rape as well as 70-80% of "hooliganism" were committed under the influence of alcohol (Reid 1986; Treml 1991).

increased alcohol prices substantially. In 1985 alone, the price of vodka, liqueurs, and cognac rose by 25% (McKee 1999), and prices were increased by about 25% more in 1986 (White 1996). Fourth, heavy new sanctions for public drunkenness and other alcohol-related offenses were introduced. Fines for workplace intoxication were one to two times the mean weekly wage, and both home production of alcohol and possession of homebrew equipment were punishable by large fines or imprisonment.

Three other measures focused on reducing the demand for alcohol. One was heavy subsidization of substitute activities; all Soviet oblasts were required to build and modernize leisure facilities (like parks and sport clubs) and to promote cultural activities. Another was media propaganda and health education programs together with bans on glamorous media depictions of drinking. To encourage sober lifestyles, the government also created a national temperance society (the "All-Union Voluntary Society for the Struggle for Temperance") – within three years, the society had 428,000 branches and more than 14 million members (White 1996). Finally, the government made large efforts to improve the treatment of alcoholism. Health care system responsibility for compulsory treatment of alcoholism was expanded, and physician supervision of treatment was required for up to five years.

Aggregate state alcohol sales fell by more than 50% between 1984 and 1988 (White 1996). Official figures overstate the decline in alcohol consumption, however, because they do not capture the "moonshining" response to the campaign. Russians have a long-standing tradition of producing *samogon* (literally, "distillate made by oneself," a generic term for illegal alcoholic beverages made from sugar, corn, beets, potatoes, and other ingredients) – and did so more vigorously during the campaign (as Appendix Figure 1 shows).[14]

[14] A fictitious type of *samogon* called *tabouretovka* is made from wooden stools (or "tabourets") (Petrov, Dovich, and Il'f 1997). There were more extreme efforts to obtain alcohol as well: sales of alcohol-based glue increased from 760 to 1000 tons between 1985 and 1987; sales of glass

Reductions in alcohol consumption also varied considerably across Russia. Central to our identification strategy, areas with higher alcohol consumption rates prior to the campaign experienced systematically larger declines during the campaign (Bleakley 2007 and 2010). Appendix Figure 2 shows oblast-level mean alcohol consumption rates for years 1980-1984, Section II describes how we use this variation in our empirical analysis, and Section III investigates the mechanisms underlying this relationship.

C. *The Demise of the Anti-Alcohol Campaign*

The Soviet Central Committee officially ended the anti-alcohol campaign in October 1988 (because of its unpopularity and the loss of revenue from alcohol sales).[15] In practice, however, the campaign extended beyond its official end for several reasons. First, increasing state production of alcohol required time; vodka production did not reach pre-campaign levels until 1993, for example (White 1996). Second, some campaign sales restrictions (against vodka sales on Sundays, for example) remained in place (White 1996). Third, alcohol prices remained high – 75% higher in 1989 than at the beginning of the campaign in 1985 (authors' calculations). Overall, the result was that the campaign lingered – both official and total alcohol consumption rates (including *samogon*) did not return to pre-campaign levels until the early 1990s. Appendix Figure 1 shows this slow recovery in our own data, concurring with Nemtsov's (2000) suggestion that 1991 was the campaign's *de facto* end date.

II. Data and Empirical Strategy

cleaners rose from 6,500 to 7,400 tons over the same period; and there was large-scale theft of industrial alcohol (Treml 1997).

[15] The campaign was also politically divisive within the communist party, and two important proponents of the campaign (Yegor Ligachev and Mikhail Solomentsev) retired from the Politburo at the end of 1987.

We used archival sources to create a new panel data set covering 77 Russian oblasts between 1970 and 2000.[16] Table 1 presents descriptive statistics from this data set by study period. In this section we summarize our key sources and variables; Appendix 1 provides greater detail about each source (the intersection of all key variables is generally years 1970, 1979, 1980, 1984-1987, and 1989-2000).

[Insert Table 1 Here]

A. *Economic, Demographic, and Alcohol Data from Goskomstat and Rosstat Yearbooks*

We obtained core demographic and alcohol variables from several types of statistical yearbooks compiled by *Goskomstat* (the Soviet national statistical agency) and *Rosstat* (the Russian Federation's national statistical agency). Some yearbook data is available through East View Information Services, a provider of Eurasian archival source materials. We obtained the remainder from the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives (available in hard-copy format in Russian).[17] To fill gaps in the coverage of these sources, we also used archival records published by scholars outside of the Soviet Union (New World Demographics 1992; Treml and Alexeev 1993; Vassin and Costello 1997; Vallin et al. 2005; Heleniak 2006).

Vital Records.— Our core mortality variables are crude death rates per 1,000 population, and alcohol poisoning death rates by gender per 100,000 population. Russian death certificates are certified by physicians (or in less than 10% of the cases, by paramedics), and evaluations of Russia's mortality statistics generally

[16] All data compiled for this project are available upon request. In addition to true administrative oblasts, our dataset contains 22 *krai* and autonomous republics as well. For simplicity, we generically refer to all of these regions as oblasts. We exclude autonomous *okrugs* from our analysis because information about them is not available for a number of years; we also exclude Chechnya and Ingushetia (typically reported together as Chechnya-Ingush prior to 1991) because of war-related inconsistencies in the data.

[17] We are grateful to Irina Erman and Emily Singer for outstanding Russian language assistance.

conclude that they are satisfactory in quality with modest under-reporting rates (Andreev 1999; Bennett, Bloom and Ivanov 1998; Leon et al. 1997).[18]

Causes of death in the Soviet Union were classified using a Soviet system with 175 categories; these categories were later harmonized with codes from the World Health Organization's International Classification of Diseases, Ninth Revision (ICD-9).[19] *Goskomstat*'s and *Rosstat*'s statistical yearbooks contain little cause-specific mortality data at the oblast level, however. Given our focus, we have compiled information on deaths directly linked to alcohol consumption (cardiovascular disease, alcohol poisoning, and accident/violent deaths), deaths more indirectly related to alcohol (digestive and respiratory disease deaths), and deaths not closely alcohol-related (cancer deaths) (Vallin et al. 2005). We obtained data on alcohol poisoning deaths for additional years from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research (Vallin et al. 2005). Other causes of deaths at the oblast level are unfortunately not available over our period of interest.

Alcohol Sales.— As the sole legal producer and distributor of alcohol in the Soviet Union, the government maintained records of alcohol sales (in liters) for principal alcoholic beverages (vodka, beer, wine, cognac, and champagne).[20]

[18] Exceptions are Tuva's statistics and regions in the North Caucasus, where reports suggest that infant mortality under-reporting was as high as 25% during the 1980s (Blum and Monnier 1989). These specific oblasts are Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. We repeat the analyses shown in Table 3 excluding these oblasts – Appendix Table 1 shows that the results are similar.

[19] The Russian Federation used the Soviet cause of death classification system until 1999 but also began using the WHO International Classification of Diseases (ICD) system in parallel in 1993 (see Shkolnikov, Mesle and Vallin 1993; Shkolnikov, McKee and Leon 2001). Cause of death records are generally less reliable than other types of mortality data, so we emphasize our crude death rate analyses but supplement them with analyses of cause-specific mortality.

[20] This data excludes information about alcohol sold on military bases. Beginning in 1992, it also excludes alcohol sales at private trade outlets and restaurants. Data for cognac and champagne sales data are only available beginning in the late 1990s (although they constitute a small share of total sales). Finally, it does not measure quality. According to the Russian Trade Committee, the share of alcoholic beverages rejected as substandard was 5.6% in 1991, rising to 12.4% in 1992, 25.6% in 1993, and 30.4% in 1994 (Nemtsov 2002).

Sales by type of beverage are reported in liters of pure alcohol for some years and in thousands of dekaliters in other (partly-overlapping) years. We converted sales data for all years into liters of pure alcohol, following Andrienko and Nemtsov (2006) by assuming each type to have the following alcohol content: vodka: 40%; wine: 14.4%; cognac: 18%; champagne: 22.8%; beer before 1995: 2.85%; beer between 1995 and 1999: 3.37%; and beer after 2000: 3.85%.[21] For each oblast-year, we divide liters of pure alcohol by the corresponding population estimate, yielding rates of pure alcohol consumption per person for years 1970, 1980-1992, and 1996-2002. White (1996) uses retrospective survey data to suggest that sales data during campaign years were generally not manipulated by politically-motivated officials.

Alcohol Production and Prices.— Prior to 1992, the Soviet government controlled alcohol production and set prices administratively (i.e., they were not determined by markets). We use the available, albeit highly incomplete, data on production and prices to speculate (in the conclusion) about the salient mechanisms through which the campaign operated. Government production data are available for vodka, the most popular alcoholic beverage during our study period (covering years 1970, 1979, 1980, 1985, and 1990-2000) and for pure alcohol production (covering years 1989-1992, 1994, 1995, 1997 and 1999-2000).[22]

Oblast-level alcohol prices are only available for post-transition years; annual vodka price data covers years 1992 forward, for example (Goskomstat Rossii 1996c; 1996d; 1997e; 1998e; 2002c; 2006c). For earlier years (1980, 1985 and 1989), we can calculate the implied annual price of pure alcohol from total sales (recorded in rubles) divided by the total quantity sold.

[21] For years possible, we verify the validity of our calculations through direct comparison with data on sales measured in pure alcohol.
[22] We use vodka's share of total alcohol production in 1990 at the oblast level to estimate vodka production in 1989.

Other Covariates.— Some of our analyses control for other determinants of mortality and for other factors proposed to explain the Russian mortality crisis. We assembled oblast-year data on health care infrastructure and workforce (the number of hospitals and the number of doctors per capita) and crude birth rates using *Goskomstat* and *Rosstat* Yearbooks. We also collected data on employment rates and employment rates in private manufacturing from Brown, Earle, and Gehlbach (2009) and Earle and Gehlbach (2010); income per capita from Treml and Alexeev (1993); and immigration and emigration flows from Andrienko and Guriev (2004).[23]

B. *Estimating Total Alcohol Consumption (Including Samogon)*

Official alcohol sales data do not accurately reflect total alcohol consumption because many Russians make *samogon* at home. Because comprehensive estimates of oblast-year *samogon* production are not available, we extend the work of Nemtsov (2000) to estimate it for the 1980s and early 1990s. Sugar is a critical ingredient in *samogon*, so one approach is based on sugar sales that exceed estimated dietary consumption (Nemtsov 1998). However, this method fails for years 1986 and later when sugar was rationed (Treml 1997).

Nemtsov (2000) therefore developed an alternative indirect technique using forensic records. Both the Soviet Union and the Russian Federation mandate that each oblast's forensic bureau perform autopsies for all violent and accidental deaths as well as deaths with unclear causes. Importantly, these mandatory autopsies systematically document blood alcohol content (albeit in a non-random sample of Russians).[24] Nemtsov (2000) used these records to estimate the association between blood alcohol concentrations and total alcohol consumption, recovering implied *samogon* consumption. Using these estimates, he then predicted *samogon* consumption for twenty-five oblasts between 1980 and 1992

[23] Other work (such as Stillman and Thomas 2008) investigates the health consequences of Russia's economic crisis late in the 1990s.

[24] The autopsy records used by Nemtsov were not made public during the Soviet era, so manipulation for external political purposes is likely not a concern.

(Nemtsov 2000).[25] Despite their imperfections, the autopsy-based estimates closely match sugar-based estimates in overlapping years and outperform other methodologies (based on hospital admissions for alcohol-induced psychosis, cirrhosis deaths, and pancreatitis deaths, for example) (McKee 1999; Nemtsov 2000; Balan-Cohen 2007).

We use estimates published in Nemtsov (2000) – together with some algebraic manipulation – to recover underlying parametric relationships (Appendix 2 describes the details of these calculations and their validation). We then use these parameters to predict oblast-year *samogon* consumption and calculate total alcohol consumption as the sum of official sales and *samogon* for years 1980-1992.[26] As Appendix Figure 1 shows, *samogon* consumption rose sharply as official alcohol sales fell during the campaign, closely matching aggregate relationships reported by others (Nemtsov 2000). In our analyses, we use both official alcohol sales and total alcohol consumption estimates in parallel.

C. *Empirical Strategy*

Our empirical approach estimates the relationship between the Anti-Alcohol Campaign and both (a) contemporaneous mortality during campaign years and (b) subsequent mortality during transition years using a reduced-form approach. Specifically, we pool together all sample years and estimate the association between oblast-year death rates and interactions of oblast-level mean alcohol consumption prior to the campaign with year dummy variables. This strategy

[25] These oblasts are Altai krai, Amur, Bashkiria, Ekaterinburg, Ivanova, Khabarovsk, Kaluga, Karelia, Kemerov, Kursk, Leningrad, Moscow city, Moscow oblast, Murmansk, Novgorod, Novosibirsk, Omsk, Orel, Rostov, Samara, Saratov, Sakhalin, St. Petersburg city, and Yaroslav.

[26] In short, Nemtsov (2000) provides an unadjusted OLS regression coefficient for the relationship between *samogon*/illegal alcohol (IA) and official alcohol sales (OS) in 1990, and he also reports correlation coefficients between official sales and *samogon* for years 1983, 1985 and 1990 (years preceding, during, and after the campaign). The regression coefficient is equal to $Cov(IA,OS)/Var(OS)$, and the correlation coefficient $r = Cov(IA,OS)/(Var(IA)^{1/2} \times Var(OS)^{1/2})$. Using the variance of official alcohol sales for years in our dataset and assuming the variance of *samogon* to remain constant over time, we calculate implied regression coefficients for each year 1980-1992. We then use these year-specific regression coefficients and our oblast-year official sales data to predict total alcohol consumption (including *samogon*).

follows Bleakley (2007, 2010), Qian (2008), Miller and Urdinola (2010), Nunn and Qian (2011) and others in assuming that areas with greater pre-campaign exposure to a disease agent benefitted more from a population-wide campaign against the disease.[27] In our case, a particular advantage of this approach is that it effectively provides a summary measure of campaign intensity (given that the campaign is highly multifaceted and that data on its individual components is generally unavailable). To flexibly trace out the differential time path of mortality in harder-drinking oblasts relative to more temperate ones during campaign and transition periods, we estimate variants of the following basic equation for oblasts *o* and years *y*:

$$(1)\quad mortality_{oy} = \alpha + \Sigma_t \beta_t [(mean\ pre\text{-}campaign\ alcohol\ consumption)_o \times (year)_{yt}] + \boldsymbol{\delta_o} + \boldsymbol{\delta_y} + \varepsilon_{oy},$$

where *mortality* is a death rate (crude death rates per 1,000 or cause-specific death rates per 100,000), (*mean pre-campaign alcohol consumption*) is the mean of oblast *o*'s total alcohol consumption during sample years prior to the campaign (1980-1984), and $\boldsymbol{\delta_o}$ and $\boldsymbol{\delta_y}$ represent oblast and year fixed effects. We also estimate variants of equation (1) that include oblast-specific linear time trends and oblast-year health system controls (doctors per capita and hospital beds per capita). We hypothesize that $\beta_t<0$ during campaign years (as oblasts with higher pre-campaign alcohol consumption are disproportionately affected by the campaign) and $\beta_t>0$ during transition years (as oblasts with larger reductions in mortality during the campaign experience larger death rate increases after its end).

D. *Graphical Evidence*

Before turning to econometric results, we first use our data set to examine graphical relationships between the anti-alcohol campaign and Russian crude

[27] This could be true for many reasons – supply restrictions could be targeted to these areas, price elasticities of demand may be greater in these areas, etc. In Section III we investigate the underlying mechanisms associated with variation in campaign intensity.

death rates. Figure 2 shows death rates over time by pre-campaign drinking rates. To construct this figure, we calculate mean total alcohol consumption in each oblast for years 1980-1984. We then graph crude death rates between 1970 and 2000 for the top and bottom quartiles of the distribution of pre-campaign alcohol consumption. Consistent with an effective anti-alcohol campaign, oblasts in the top quartile experienced larger crude death rate reductions in the latter 1980s during the campaign. Then, during Russia's subsequent political and economic transition, this relationship reverses. Between 1990 and 1994, larger crude death rate increases occurred among oblasts with more pre-campaign drinking – and oblasts with less pre-campaign drinking experienced smaller increases. Overall, Figure 2 is consistent with the campaign's end playing an important role in the mortality crisis.

[Insert Figure 2 Here]

III. Results

A. *Russian Mortality during the Anti-Alcohol Campaign*

Alcohol Consumption and Mortality.— In estimating equation (1), we assume that oblasts with higher pre-campaign alcohol consumption (i.e., that had greater pre-campaign exposure to a disease-causing agent) benefitted relatively more from the population-wide campaign through larger reductions in alcohol consumption. Before analyzing changes in crude death rates, we first show that empirical patterns of drinking over time support this assumption. Regressing per capita alcohol consumption on interactions between mean pre-campaign alcohol consumption and campaign year dummies, Table 2 shows that each additional liter of alcohol consumed per person per year prior to the campaign is associated

with 28%-69% decline in per capita alcohol consumption during campaign years.[28]

[Insert Table 2 Here]

We then directly estimate changes in crude death rates during the Anti-Alcohol Campaign using equation (1). Table 3 reports year-specific β estimates, tracking differential mortality time paths of oblasts with varying levels of pre-campaign alcohol consumption. Focusing on the 1980s, these estimates fall significantly below zero in 1985 and continue to fall further during the campaign, reaching their lowest point in 1988 (significantly lower than in 1985) before rising again and becoming insignificant by the time of transition. Table 3 shows that this pattern of results is robust to the inclusion of oblast-specific linear time trends and other available oblast-year controls (per capita number of doctors and per capita number of hospital beds).[29] Appendix Table 1 also shows that these results are not generally sensitive to the exclusion of oblasts with lower quality vital statistics.[30]

[Insert Table 3 Here]

Figure 3 shows death rate changes and 95% confidence intervals implied by median pre-campaign alcohol consumption (14.38 liters per capita each year) throughout the 1980s and 1990s. This figure is based on our flexible reduced-form estimates of the effect of changes in alcohol consumption (with a median decline of about 20% during campaign years). During the campaign, the median oblast's mortality decline in 1985 was -2.07 per 1,000 population, falling to -3.46

[28] We use sample years prior to 1990 to estimate this relationship (we only have our total alcohol consumption measure for years up to 1992).
[29] Instead of the reduced-form approach in Table 3, we can also use a similar TSLS strategy, instrumenting for campaign-year alcohol consumption with average pre-campaign alcohol consumption interacted with year dummies. While the TSLS estimates generally corroborate our reduced-form findings (available upon request), they only identify the contemporaneous mortality effect of the campaign and ignore important dynamic effects which our reduced-form approach captures.
[30] Footnote 20 provides the names of these oblasts.

per 1,000 in 1988 and rising back towards zero by 1990. This temporal pattern of implied changes in crude death rates closely matches the year-to-year aggregate deviations during the campaign from Russia's long-term death rate trend shown in Figures 1a and 1b.[31] Scaling the implied death rate changes by Russia's population in 1984, they imply approximately 1.6 million fewer deaths during the four campaign years, with annual death rates 24% below pre-campaign rates (on average).[32]

[Insert Figure 3 Here]

B. *The Anti-Alcohol Campaign and Russian Mortality during the 1990s*

Having established the relationship between the Anti-Alcohol Campaign and reductions in mortality during the 1980s, we then investigate how the end of the campaign is related to the subsequent surge in mortality during Russia's political and economic transition. Returning to Table 3, we examine year-specific β estimates from equation (1) for years throughout the 1990s. These estimates track how increases in transition-era mortality vary with pre-campaign alcohol consumption – and mortality declines during the preceding campaign. After returning to zero in 1991/1992, the estimates then become positive in 1993, rise sharply to their peak in 1994/1995, and then fall again in the latter 1990s. Importantly, this temporal pattern of estimates closely matches aggregate deviations from the long-term mortality trend during crisis years as shown in Figures 1a and 1b.

[31] Appendix Table 3 reports implied crude death rates changes at median pre-campaign alcohol consumption as well as one standard deviation above and below the median.

[32] Averted deaths are calculated by first multiplying coefficient estimates for interactions between pre-campaign mean alcohol consumption and year dummies with median pre-campaign consumption, yielding implied changes in crude death rates. For 1985, 1986, 1988, and 1989, this is: -0.14×14.38=-2.07, -0.20×14.38=-2.81, -0.24×14.38=-3.47, and -0.21×14.38=-3.03 (respectively). These implied changes in crude death are then scaled by the size of the Russian population in 1984 (141,525,504) to obtain implied deaths averted. For 1985, 1986, 1988, and 1989, this is: 293,059; 398,887; 490,468; and 429,414 deaths averted (respectively). Summing over campaign years yields 1,611,828 averted deaths.

Figure 3 plots changes in death rates implied by these estimates for median pre-campaign alcohol consumption. At the height of the mortality crisis rebound in death rates, excess deaths implied by our model were 5.85 per 1,000. Scaling these estimates by Russia's population in 1989, this implies 2.15 million excess deaths between 1992 and 1995, an average increase of 43% across these years relative to 1989.[33] Although our estimates are accompanied by wide confidence intervals, they suggest that the end of the Anti-Alcohol Campaign played a leading role in explaining Russia's mortality crisis.

Cause-Specific Mortality.— Next, we examine changes in three groups of cause-specific death rates with differential relatedness to alcohol consumption. Those most closely related to alcohol are alcohol poisonings, deaths due to cardiovascular disease, and accidents/violent deaths. Causes more indirectly linked to alcohol are respiratory diseases and digestive diseases. Finally, cancer deaths are most weakly related to alcohol (and occur only after a long period of time).

Estimating equation (1) using cause-specific deaths per 100,000 as dependent variables, Figures 4, 5a and 5b show implied changes in cause-specific mortality for median pre-campaign alcohol consumption.[34] Alcohol poisonings, circulatory disease deaths, and accidents/violent deaths rise considerably during the early 1990s in proportion to intensity of the Gorbachev Anti-Alcohol Campaign, and their temporal pattern matches the changes in crude death rates implied by Table

[33] Relative to 1989, there were 223,698 excess deaths in 1992, 545,596 in 1993, 717,623 in 1994, and 620,067 in 1995. We calculated the number of implied excess deaths by first multiplying coefficient estimates for interactions between pre-campaign mean alcohol consumption and year dummies with median pre-campaign consumption, yielding implied changes in crude death rates. For 1992, 1993, 1994, and 1995, this is: 0.047×14.38=0.68, 0.221×14.38=3.18, 0.34×14.38=4.89, and 0.407×14.38=5.85 (respectively). These implied changes in crude death rates are then scaled by the population in 1989 to obtain implied excess deaths. For 1992, 1993, 1994, and 1995, this is: 99,338; 467,101; 718,617; and 860,227 excess deaths (respectively), totaling 2,145,283 deaths.

[34] See Appendix Table 2 for the complete regression results.

3. Consistent with gender differences in alcohol consumption (see Bobak et al. 1999 and Zaridze et al. 2009, for example), Figure 4 shows that alcohol poisonings rise much more for men than for women. Figure 5a then shows that the most quantitatively important increases occur among cardiovascular disease deaths and accidents/violence (a large medical literature implicates alcohol consumption as a leading risk factor for heart attacks and strokes).[35] Predicted respiratory and digestive disease death rates rise to lower levels (consistent with their weaker relationship to alcohol consumption), and the trajectory of predicted cancer deaths is essentially flat throughout the 1990s (shown in Figure 5b).[36]

[Insert Figures 4, 5a and 5b Here]

Robustness to Controlling for Local Economic Conditions.— We then consider alternative explanations for our main findings. Given the emphasis that previous research on the mortality crisis has placed on changing economic circumstances, we begin by assessing the robustness of our results to the inclusion of controls for local economic conditions. Oblast-year data is available for real income, the employment rate, and the employment rate in private manufacturing ("privatization") in years 1991 and later. We first re-estimate equation (1) using data from these years – and we then repeat our estimation including these local economic controls. Table 4 Panel A shows that our estimates without economic controls (indexed to 1991) exhibit the same temporal pattern of mortality throughout the 1990s – and importantly, the estimates do not change in a meaningful way with these additional controls. Our findings therefore suggest that campaign-related increases in death rates during the 1990s cannot be explained by "privatization" or other changes in local economic conditions.

[Insert Table 4 Panel A Here]

[35] The medical literature suggests that cardiovascular disease deaths should be quantitatively most important (Chenet et. al. 1998; Britton and Mckee 2000; Corrao et. al. 2000; Hemström 2001; McKee, Shkolnikov, and Leon 2001; Corrao et. al. 2002; Ramstedt 2009).
[36] Similarly, infant mortality is not associated with campaign intensity during the transition era.

We then assess the sensitivity of our findings to other oblast-year controls (immigration and emigration as well as health system measures). These controls are available for years 1990 and forward, so we re-estimate equation (1) using these years and then include the additional controls. As Table 4 Panel B shows, our results again do not appear to be explained by these other factors.

[Insert Table 4 Panel B Here]

IV. Simulations and Cross-Country Evidence

A. *Simulation Evidence on the Temporal Relationship between Alcohol Consumption and Mortality*

Although the anti-alcohol campaign lingered for several years after its official repeal (alcohol consumption did not reach its pre-campaign levels until the early 1990s), the Russian mortality crisis followed the campaign's end by several years. This temporal relationship is unsurprising given that the consequences of drinking become manifest over time (as subsequent heart attacks and strokes, for example). To investigate more carefully the timing of deaths following a sharp decrease and subsequent resumption of drinking, we use unique longitudinal data from the Framingham Heart Study in the United States to estimate mortality hazards associated with alcohol consumption. Using these estimates, we then simulate reductions in drinking analogous to those under the anti-alcohol campaign followed by increases in drinking observed during Russia's political and economic transition.[37] Overall, we find strikingly similar temporal patterns of mortality, with excess deaths emerging 2-3 years after the resumption of pre-campaign drinking and lasting for more than a decade. Appendix 3 presents these analyses in detail.

[37] Levels of alcohol consumption vary from country to country; however, the simulations will still be informative about the mortality response to sudden (and drastic) changes in alcohol consumption.

B. *The Anti-Alcohol Campaign across Other Former Soviet States and Eastern Europe*

Finally, if the Gorbachev Anti-Alcohol Campaign explains an important part of the Russian Mortality Crisis, then temporal patterns of mortality commensurate with campaign exposure should be present across other Eastern European countries. Other former Soviet states also experienced the campaign, and the campaign's impact should vary systematically with ethnic/religious composition (with larger campaign-year reductions and larger transition-year increases in countries with lower concentrations of Muslims).[38] Alternatively, non-Soviet Eastern European countries had no anti-alcohol campaign – and therefore should have different temporal patterns of mortality despite experiencing similar political and economic transitions.

Figure 6 shows crude death rate comparisons between Russia and three groups of countries: former Soviet states with a small share of Muslims (Latvia, Lithuania, Estonia, Ukraine, Belarus, and Moldova), former Soviet states with a larger share of Muslims (Armenia, Azerbaijan, Georgia, Uzbekistan, Kazakhstan, Kyrgyzstan, and Turkmenistan), and non-Soviet Eastern European countries (the Czech Republic, the Slovak Republic, Hungary, and Poland). Each panel shows de-trended crude death rate means for one of these country groups (and Russia for comparison), plotting residuals obtained by regressing country-year crude death rates on a linear year variable (Demoscope 2009; World Bank 2010). Former Soviet states with low Muslim concentrations exhibit both crude death rate decreases during the latter 1980s and death rate increases during the early 1990s similar to those in Russia. Alternatively, former Soviet states with higher Muslim concentrations experienced campaign year reductions and transition year-

[38] Given Islam's prohibition of intoxicants, we exploit variation in the concentration of Muslims across the former Soviet Union. The underlying logic is that former Soviet states with relatively more Muslims should experience smaller absolute declines in deaths during the campaign and smaller increases in mortality during transition years. Guillot, Gavrilova, and Pudrovska (2011) report congruent evidence from Kyrgyzstan.

increases that are muted considerably. Finally, death rates over time in non-Soviet Eastern European countries appear unrelated to those in Russia (see also Mesle 2004). These patterns of mortality during the 1980s and 1990s across former Soviet States and Eastern European countries are consistent with our oblast-level findings for Russia.

[Insert Figure 6 Here]

V. Conclusion

This paper demonstrates an important but under-recognized link between the Gorbachev Anti-Alcohol Campaign and Russia's mortality crisis. Intervening on a variety of margins, the campaign simultaneously raised the cost of drinking and subsidized substitute activities. Alcohol consumption declined markedly, and Russia's crude death rate fell by an average of 24% per year, implying roughly 1.61 million fewer deaths during the latter 1980s. However, the campaign's unpopularity and public finance impact led to its repeal shortly before the collapse of the Soviet Union. The Russian death rate subsequently climbed rapidly – and the increase associated with the campaign's end explains a large share of the Russia's Mortality Crisis (roughly 2.15 million deaths). Former Soviet States and the rest of Eastern Europe also experienced similar temporal patterns of mortality commensurate with their exposure to the Anti-Alcohol Campaign.

If our thesis is correct, then an important subsequent question is: through what underlying behavioral factors did the campaign operate? Unfortunately, data limitations prevent us from providing a definitive answer. In one approach that we tried, we estimated variants of equation (1) to analyze the campaign's relationship with both official state production of vodka and an alcohol price index. The results suggest little evidence that our summary measure of campaign intensity operates either through differential supply shifts or through differential

price increases. However, we are hesitant to draw conclusions given the limitations of the state vodka production and alcohol price index data noted earlier. We emphasize that this is an important area for further research.

Overall, a key implication of our main findings is that Russia's transition to capitalism and democracy was not as lethal as commonly suggested (Stuckler, King, and McKee 2009). However, our findings also do not necessarily imply that alcohol prohibition raises welfare (in Russia or elsewhere), even if it saves lives. Health is only one argument of welfare, and health-improving restrictions on individual choices can cause harm as well as do good.[39]

[39] Negative externalities and the role of addiction introduce ambiguity into welfare evaluations of alcohol policies and are beyond the scope of our paper (Becker and Murphy 1988; Becker, Grossman, Murphy 1994; Gruber and Koszegi 2001).

References

Andreev, Evgueni M. 1999. "The Dynamics of Mortality in the Russian Federation." In *Health and Mortality: Issues of Global Concern*, edited by the United Nations. New York: United Nations.

Andrienko, Yuri, and Sergei Guriev. 2004. "Determinants of Interregional Mobility in Russia," *Economics of Transition*. 12(1): 1-27.

Andrienko, Yuri, and Alexander Nemtsov. 2006. "Estimation of Individual Demand for Alcohol." CEFIR/NES Working paper #89. Moscow, Centre for Economic and Financial Research at New Economic School.

Avdeev, Alexandre, Alain Blum, Sergei Zakharov, and Evgueni Andreev. 1998. "The Reactions of a Heterogeneous population to Perturbation: An Interpretative Model of Mortality Trends in Russia." *Population: An English Selection* 10: 267-302.

Balan-Cohen, Andreea. 2007. "Sobering Up: The Impact of the 1985-1988 Russian Anti-Alcohol Campaign on Child Health." Unpublished.

Becker, Gary, Michel Grossman, and Kevin Murphy. 1994. "An Empirical Analysis of Cigarette Addiction." *American Economic Review* 84(3): 396-418.

Becker, Gary, and Kevin Murphy. 1988. "A Theory of Rational Addiction." *Journal of Political Economy* 96(4): 675-700.

Bennett, Neil, David Bloom, and Serguey Ivanov. 1998. "Demographic Implications of the Russian Mortality Crisis." *World Development* 26: 1921-1937.

Bleakley, Hoyt. 2007. "Disease and Development: Evidence from Hookworm Eradication in the American South." *Quarterly Journal of Econmics* 122: 73-117.

Bleakley, Hoyt. 2010. "Malaria Eradication in the Americas: A Retrospective Analysis of Childhood Exposure." *American Economic Journal: Applied Economics* 2: 1-45.

Blum, Alain, and Alain Monnier. 1989. "Recent Mortality Trends in the U.S.S.R.: New Evidence." *Population Studies* 43: 211-241.

Bobak, Martin, and Michael Marmot. 1996. "East-West Mortality Divide and its Potential Explanations: Proposed Research Agenda." *BMJ* 312: 421.

Bobak, Martin, and Michael Marmot. 1999. "Alcohol and Mortality in Russia: Is It Different than Elsewhere?" *Annals of Epidemiology* 9: 335-338.

Bobak, Martin, Martin McKee, Richard Rose, and Michael Marmot. 1999. "Alcohol Consumption in a National Sample of the Russian Population." *Addiction* 94: 857-866.

Brainerd, Elizabeth. 2001. "Economic Reform and Mortality in the Former Soviet Union: A Study of the Suicide Epidemic in the 1990s." *European Economic Review* 45: 1007-1019.

Brainerd, Elizabeth, and David Cutler. 2005. "Autopsy on an Empire." *Journal of Economic Perspectives* 19: 107-130.

Britton, Annie, and Martin Mckee. 2000. "The Relation between Alcohol and Cardiovascular Disease in Eastern Europe: Explaining the Paradox." *Journal of Epidemiology and Community Health* 54: 328-332.

Brown, J. David, John S. Earle, and Scott G. Gehlbach. 2009. "Helping Hand or Grabbing Hand? State Bureaucracy and Privatization Effectiveness." *American Political Science Review* 103(2): 264-283.

Chenet, Laurent, Martin McKee, David Leon, Vladimir Shkolnikov, and Sergei Vassin. 1998. "Alcohol and Cardiovascular Mortality in Moscow: New Evidence of a Causal Association." *Journal of Epidemiology and Community Health* 52: 772-774.

Cockerham, Willi. 1999. *Health and Social Change in Russia.* New York: Routledge.

Cornia, Giovanni A., and Renato Paniccià. 2000. "The Transition Mortality Crisis: Evidence, Interpretation and Policy Responses." In *The Mortality Crisis in Transitional Economies,* edited by Giovanni A. Cornia, and Renato Paniccià. Oxford: Oxford University Press.

Corrao, Giovanni, Luca Rubbiati, Vincenzo Bagnardi, Antonella Zambon, and Kari Poikolainen. "Alcohol and Coronary Heart Disease: A Meta-Analysis." *Addiction* 95(10): 1505-1523.

Corrao, Giovanni, Luca Rubbiati, Antonella Zambon, and Sarino Aricò. 2002. "Alcohol-Attributable and Alcohol-Preventable Mortality in Italy: A Balance in 1983 and 1996." *European Journal of Public Health* 12(3): 214-223.

Demoscope Weekly. 2009. "Mortality in Russia through the Prism of Privatization." February 15.

Denisova, Irina. 2010. “Adult Mortality in Russia: A Microanalysis.” *Economics of Transition* 18(2): 333-363.

Earle, John S., and Scott G. Gehlbach. 2010. “Did Mass Privatization Really Increase Post-Communist Mortality?” *The Lancet* 375: 372.

The Economist. 2009. “Mass Murder and the Market.” January 22.

Ellman, Michael. 1994. “The Increase in Death and Disease under ‘Katastroika.” *Cambridge Journal of Economics* 18(4): 329-355.

Gavrilova, Natalia S., Victoria G. Semyonova, Galina N. Evdokushkina, Leonid A. Gavrilov (2000). The response of violent mortality to economic crisis in Russia. *Population Research and Policy Review*, 19: 397-419.

Gavrilova Natalia S., Galina N. Evdokushkina, Victoria G. Semyonova, and Leonid A. Gavrilov. 2001. “Economic Crises, Stress and Mortality in Russia.” Paper presented at The Population Association of America Annual Meeting.

Gerry, Christopher, Tomasz Mickiewicz, and Zlatko Nikoloski. 2010. “Did Mass Privatization *Really* Increase Post-Communist Mortality?” *The Lancet* 375: 371.

Gruber, Jonathan, and Botond Koszegi. 2001. “Is Addiction Rational? Theory and Evidence.” *Quarterly Journal of Economics*, 116(4): 1261-1303.

Guillot, Michel, Natalia S. Gavrilova, and Tetyana Pudrovska. 2011. “Understanding the “Russian Mortality Paradox in Central Asia: Evidence from Kyrgyzstan.” *Demography* 48: 1081-1104.

Heleniak, Timothy. 2006. “Regional Distribution of the Muslim Population of Russia.” *Eurasian Geography and Economics* 47: 426-448.

Hemström, Örjan. 2001. “Per Capita Alcohol Consumption and Ischaemic Heart Disease Mortality.” *Addiction* 96: S93-S112.

Holder, Harold, and Robert N. Parker. 1992. “Effect of Alcoholism Treatment on Cirrhosis Mortality: A 20-Year Multivariate Time Series Analysis.” *British Journal of Addiction* 87: 1263-1274.

Human Mortality Database. 2011. Departmetn of demography at the University of California, Berkeley and the Max Planck Institute for Demographic Research, Rostock, Germany. http://www.mortality.org/cgi-bin/hmd/country.php?cntr=RUS&level=1

Ilf, Ilya and Eygeny Petrov. 1997. *The Twelve Chairs*. Evanston, IL: Northwestern University Press.

Kennedy, Bruce, Ichiro Kawachi, and Elizabeth Brainerd. 1998. "The Role of Social Capital in the Russian Mortality Crisis." *World Development* 26(11): 2029-2043.

Laonigro, Irma, Michele Correale, Matteo Di Biase, and Emanuele Altomare. 2009. "Alcohol Abuse and Heart Failure." *European Journal of Heart Failure* 11: 453-462.

Leon, David, Laurent Chenet, Vladimir Shkolnikov, Sergi Zakharov, Judith Shapiro, Galina Rakhmanova, Sergei Vassin, and Martin McKee. 1997. "Huge Variation in Russian Mortality Rates in 1984-1994. Artifact, Alcohol or What?" *The Lancet* 350: 383-388.

Leon, David, and Vladimir Shkolnikov. 1998. "Social Stress and the Russian Mortality Crisis." *Journal of the American Medical Association* 279: 790-791.

Leon, David, Lyudmila Saburova, and Susannah Tomkins, Eygueny Andreev, Nikolay Kiyanov, Martin McKee, and Vladimir Shkolnikov. 2007. "Hazardous Alcohol Drinking and Premature Mortality in Russia: A Population Based Case-Control Study." *The Lancet* 369: 2001–2009.

Lynch, John, George Davey Smith, George Kaplan, and James House. 2000. "Income Inequality and Mortality: Importance to Health of Individual Income, Psychosocial Environment, or Material Conditions." *BMJ* 320(7243): 1200-1204.

Malyutina, Sofia, Martin Bobak, Svetlana Kurilovitch, Eva Ryizova, Yuri Nikitin, and Michael Marmot. 2001. "Alcohol Consumption and Binge Drinking in Novosibirsk, Russia, 1985-95." *Addiction* 96: 987-995.

McKee, Martin. 1999. "Alcohol in Russia." *Alcohol and Alcoholism* 34: 824-829.

McKee, Martin, and Annie Britton. 1998. "The Positive Relationships between Alcohol and Heart Disease in Eastern Europe: Potential Physiological Mechanisms." *Journal of the Royal Society of Medicine* 91: 402-407.

McKee, Martin, Vladimir Shkolnikov, and David Leon. 2001. "Alcohol is Implicated in the Fluctuations in Cardiovascular Disease in Russia since the 1980s." *Annals of Epidemiology* 11: 1-6.

Mesle, France. 2004. "Mortality in Central and Eastern Europe: Long-Term Trends and Recent Upturns." *Demographic Research Special Collection* 2: 43-70.

Mesle, France, Vladimir Shkolnikov, Hertrich Veronique, and Jacques Vallin. 1996. “Tendances Recentes de la Mortalite par Cause en Russie, 1965-1994.” Paris: Institut National d'Etudes Demographiques.

Miller, Grant and B. Piedad Urdinola. 2010. “Cyclicality, Mortality, and the Value of Time: The Case of Coffee Price Fluctuations and Child Survival in Colombia.” *Journal of Political Economy* 118: 113-155.

Nemtsov, Alexander. 1998. “Alcohol-Related Harm and Alcohol Consumption in Moscow before, during and after a Major Anti-Alcohol Campaign.” *Addiction* 93: 1501–1510.

Nemtsov, Alexander. 2000. “Estimates of Total Alcohol Consumption in Russia, 1980-1994,” *Drug and Alcohol Dependence* 58: 133-142.

Nemtsov, Alexander. 2002. “Alcohol-Related Human Losses in Russia in the 1980s and 1990s.” *Addiction*, 97(2002), 1413-1425.

New World Demographics. 1992. *The First Book of Demographics for the Republics of the Former Soviet Union, 1951-1990*. Shady Side, MD.: New World Demographics, L.C.

Nunn, Nathan, and Nancy Qian. 2011. “The Potato’s Contribution to Population and Urbanization: Evidence from a Historical Experiment.” *Quarterly Journal of Economics* 126: 593-650.

O’Keefe, James, Kevin Bybee, and Carl Lavie. 2007. “Alcohol and Cardiovascular Health: The Razor-Sharp Double-Edged Sword.” *Journal of the American College of Cardiology* 50: 1009–dsa1014.

Partanen, Juha. 1993. “Failures in Alcohol Policy: Lessons from Russia, Kenya, Truk and History.” *Addiction* 88: 129S-134S.

Qian, Nancy. 2008. “Missing Women and the Price of Tea in China: The Effect of Sex-Specific Earnings on Sex Imbalance.” *Quarterly Journal of Economics* 123: 1251-1285.

Ramstedt, Mats. 2009. “Fluctuations in Male Ischaemic Heart Disease Mortality in Russia 1959-1998: Assessing the Importance of Alcohol.” *Drug and Alcohol Review* 28: 390-395.

Rehm, Jurgen, Colin Mathers, Svetlana Popova, Montarat Thavorncharoensap, Yot Teerawattananon, and Jayadeep Patra. 2009. “Global Burden of Disease and Injury and Economic Cost Attributable to Alcohol Use and Alcohol-Use Disorders.” *The Lancet* 373: 2223-2233.

Reid, Carl. 1986. “Soviet Social Reform in the 1980s: The Anti-Alcohol Campaign as Antidote for a Flagging Economy.” Ottawa, Canada: Department of National Defense.

Reitan, Therese. 2001. “The Operation Failed but the Patient Survived. Varying Assessments of the Soviet Union’s Last Anti-Alcohol Campaign.” *Communist and Post-Communist Studies* 34: 241-260.

Richardson, Erica. 1999. “The Struggle for Sobriety under Gorbachev and Yeltsin.” *Research Papers in Russian and East European Studies* 1.

Ryan, Michael. 1995. “Alcoholism and Rising Mortality in the Russian Federation.” *BMJ* 310(6980): 646-649.

Sachs, Jeffrey. 2009. “Shock Therapy Had No Adverse Effect on Life Expectancy in Eastern Europe.” *The Financial Times,* January 19.

Savolainen, Vesa, Antti Penttila, A., and Pekka J. Karhunen. 1992. “Delayed Increases in Liver Cirrhosis Mortality and Frequency of Alcoholic Liver Cirrhosis following an Increment and Redistribution of Alcohol Consumption in Finland: Evidence from Mortality Statistics and Autopsy Survey covering 8533 Cases in 1968-1988.” *Alcoholism: Clinical & Experimental Research* 16: 661-664.

Segal, Boris M. 1990. *The Drunken Society – Alcohol Abuse and Alcoholism in the Soviet Union.* New York: Hippocrene Books.

Shapiro, Judith. 1995. “The Russian Mortality Crisis and Its Causes.” In *Russian Economic Reform in Jeopardy?* edited by Anders Aslund. London: Pinter Publishers.

Shkolnikov, Vladimir M., Giovanni Cornia, , David Leon, and France Mesle. 1998. “Causes of the Russian Mortality Crisis: Evidence and Interpretations.” *World Development* 26: 1995-2011.

Shkolnikov, Vladimir M., Martin McKee, and David Leon. 2001. “Changes in Life Expectancy in Russia in the Mid-1990s.” *The Lancet* 257: 917-921.

Shkolnikov, Vladimir M., France Meslé, and Jacques Vallin. 1993. “Health Crisis in Russia. I. Recent Trends in Life Expectancy and Causes of Death from 1970 to 1993.” *Population: An English Selection* 8: 123-154.

Shkolnikov, Vladimir M., and Alexander V. Nemtsov. 1997. “The Anti-Alcohol Campaign and Variations in Russian Mortality.” In *Premature Deaths in the New*

Independent States, edited by Jose Luis Bobadilla, Christine A. Costello, and Faith Mitchell. Washington: National Academy Press.

Staiger, Douglas. and James H. Stock. 1997. "Instrumental Variables Regression with Weak Instruments." *Econometrica* 65: 557–586.

Stillman, Steven, and Duncan Thomas. 2008. "The Effect of Economic Crises on Nutritional Status: Evidence from Russia." *Economic Journal* 118: 1385-1417.

Stuckler, David, Lawrence King, and Martin McKee. 2009. "Mass Privatisation and the Post-Communist Mortality Crisis: A Cross-National Analysis." *The Lancet* 373: 399-407.

Stuckler, David, Lawrence King, and Martin McKee 2012. "The disappearing health effects of rapid privatization: A case of statistical obscurantism?" *Social Science and Medicine* 75: 23-31.

Takala, I.R. 2002. *Veseliie Rusi: istoriia alkogol'noi problem v Rossii*. St. Petersburg: Zhumal Neva.

Tarschys, Daniel. 1993. "The Success of a Failure: Gorbachev's Alcohol Policy, 1985-88." *Europe-Asia Studies* 45(1): 7-25.

Tolstrup Janne, Majken K. Jensen, Anne Tjonneland, Kim Overvad, Kenneth J. Mukamal, and Morten Gronbaek. 2006. "Prospective Study of Alcohol Drinking Patterns and Coronary Heart Disease in Women and Men." *BMJ* 332: 1244–1248.

Treisman, Daniel. 2010. "Death and Prices: The Political Economy of Russia's Alcohol Crisis," *Economics of Transition* 18(2): 281-331.

Treml, Vladimir G. 1982. *Alcohol in the USSR: A Statistical Study*. Durham, N. C.: Duke University Press.

Treml, Vladimir G. 1987. "Drinking and Alcohol Abuse in the USSR in the 1980s." In *Quality of Life in the Soviet Union*, edited by Horst Herlemann. Boulder, CO: Westview Press.

Treml, Vladimir G. 1991. "Drinking and Alcohol Abuse in the USSR in the 1980s." In *Soviet Social Problems*, edited by Anthony Jones, Walter D. Connor, David E. Powell. New York: Westview Press.

Treml, Vladimir G. 1997. "Soviet and Russian Statistics on Alcohol Consumption and Abuse." In *Premature Deaths in the New Independent States*, edited by Jose Luis Bobadilla, Christine A. Costello, and Faith Mitchell. Washington: National Academy Press.

Treml, Vladimir G., and Michael Alexeev. 1993. "The Second Economy and the Destabilizing Effect of Its Growth on the State Economy in the Soviet Union: 1965-1989." *Berkeley-Duke Occasional Papers on the Second Economy in the USSR No. 36*.

Vallin, Jacques, Evgueni Andreev, France Mesle, and Vladimir Shkolnikov. 2005. "Geographical Diversity of Cause-of-Death Patterns and Trends in Russia." *Demographic Research* 12: 323-380.

Vallin, Jacques, France Meslé, Vladimir Shkolnikov, and Veronique Hertrich. 1996. "Tendances Récentes de la Mortalité par Cause en Russie, 1965–1994." Mimeo, Paris: INED.

Vassin, Sergei and Christine A. Costello. 1997. "Spatial, Age, and Cause-of-Death Patterns of Mortality in Russia, 1988-1989." In *Premature Deaths in the New Independent States*, edited by Jose Luis Bobadilla, Christine A. Costello, and Faith Mitchell. Washington: National Academy Press.

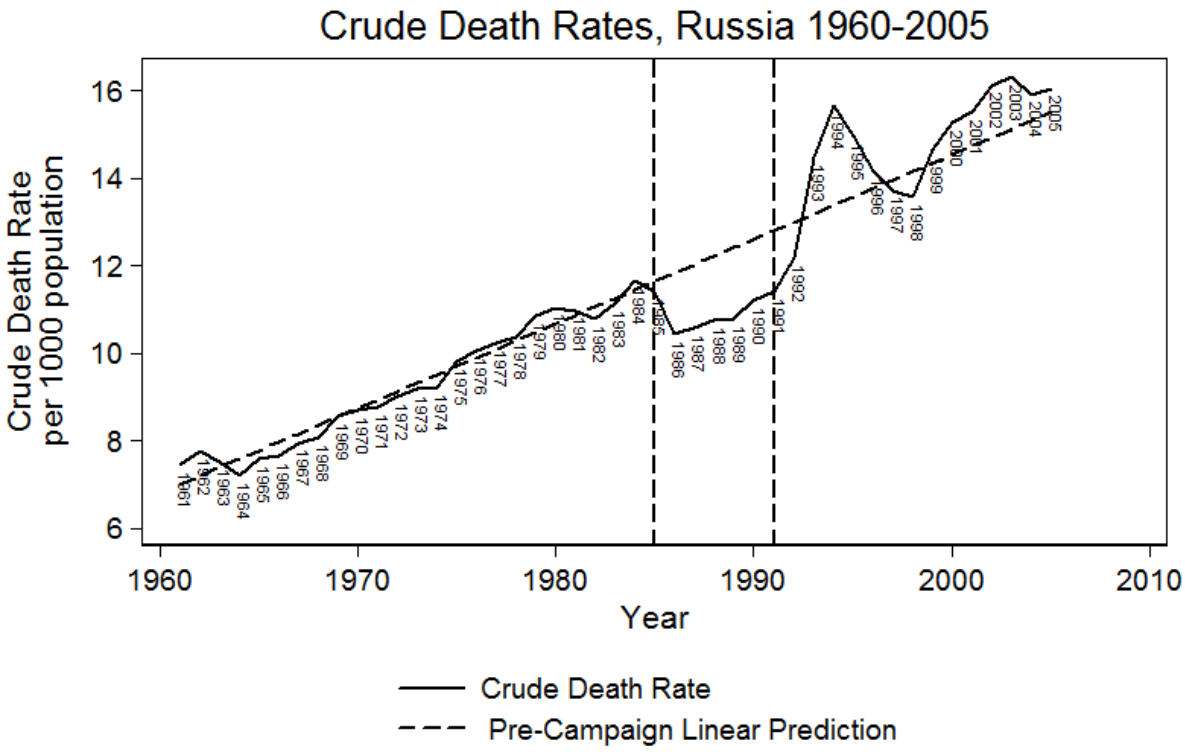
Walberg, Peder, Martin McKee, Vladimir Shkolnikov, Laurent Chenet, and David Leon. 1998. "Economic Change, Crime, and Mortality Crisis in Russia: Regional Analysis." *BMJ* 317: 312-318.

White, Stephen. 1996. *Russia Goes Dry: Alcohol, State and Society*. New York: Cambridge University Press.

World Bank. 2010. "*World Development Indicators.*" available online at: http://data.worldbank.org/data-catalog/world-development-indicators.

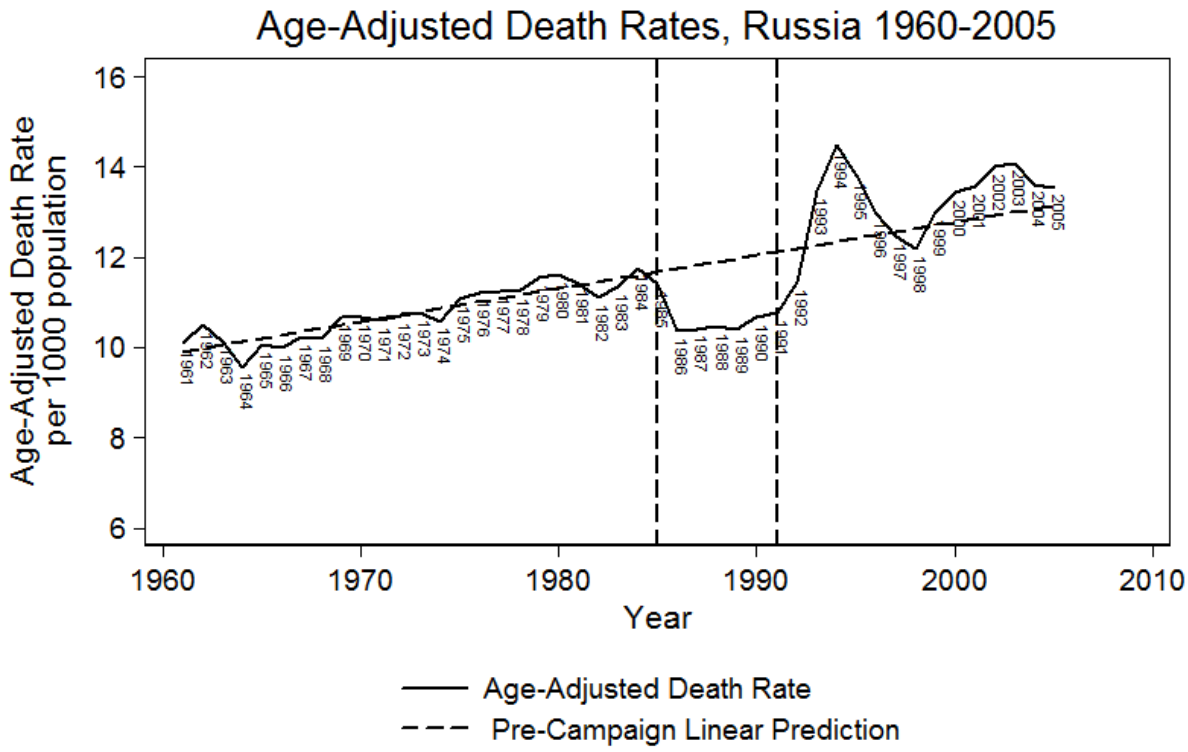
Zaridze, David, Paul Brennan, Jillian Boreham, Alex Boroda, Rostislav Karpov, Alexander Lazarev, Irina Konobeevskaya, Vladimir Igitov, Tatiana Terechova, Paolo Boffetta and Richard Peto. 2009. "Alcohol and Cause-Specific Mortality in Russia: A Retrospective Case-Control Study of 48,557 Adult Deaths." *The Lancet* 373: 2201-2214.

Figure 1a



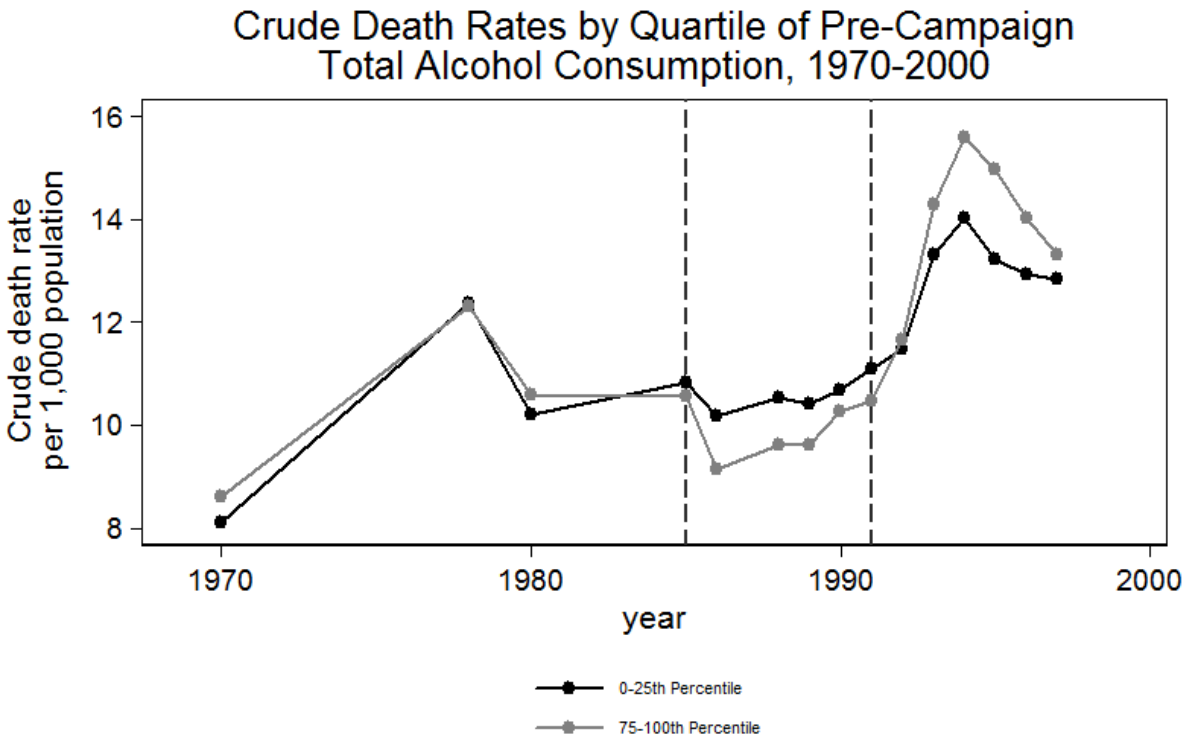
Data available from The Human Mortality Project (2011). Pre-campaign linear trend estimated using ordinary least squares regression of mortality per 1,000 population on pre-campaign year.

Figure 1b



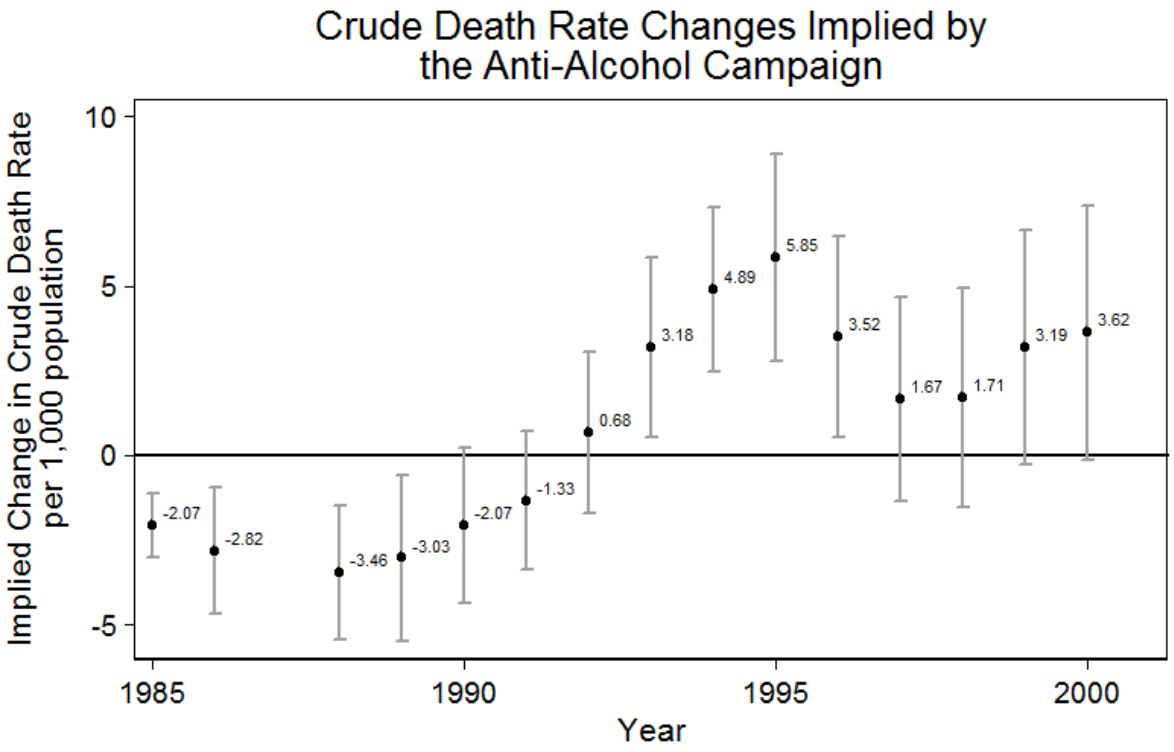
Data available from The Human Mortality Project (2011). Pre-campaign linear trend estimated using ordinary least squares regression of mortality per 1,000 population on pre-campaign year.

Figure 2



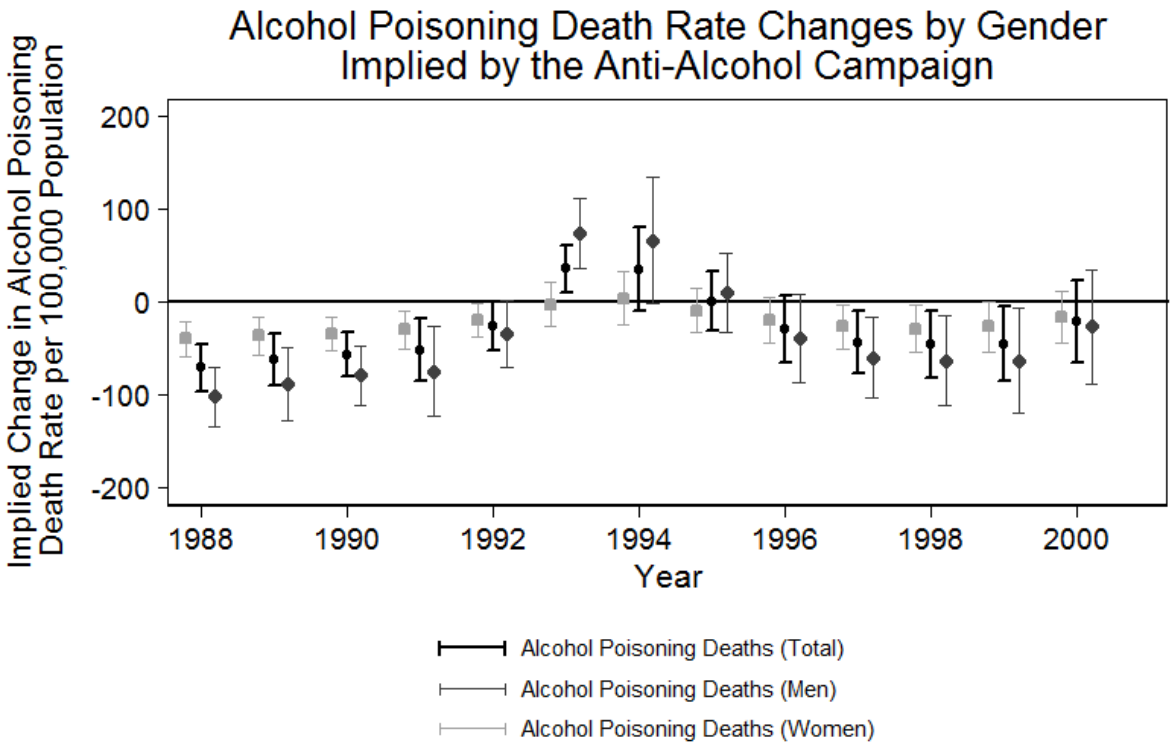
Crude death rates (per 1,000 population) plotted for oblasts in the top and bottom quartile of alcohol consumption prior to Anti-Alcohol Campaign. Estimates of total alcohol consumption use data on official alcohol sales and estimates of illegal alcohol production. Data on official alcohol sales are available in annual statistical yearbooks compiled by Goskomstat and Rosstat; illegal alcohol production estimated by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Figure 3



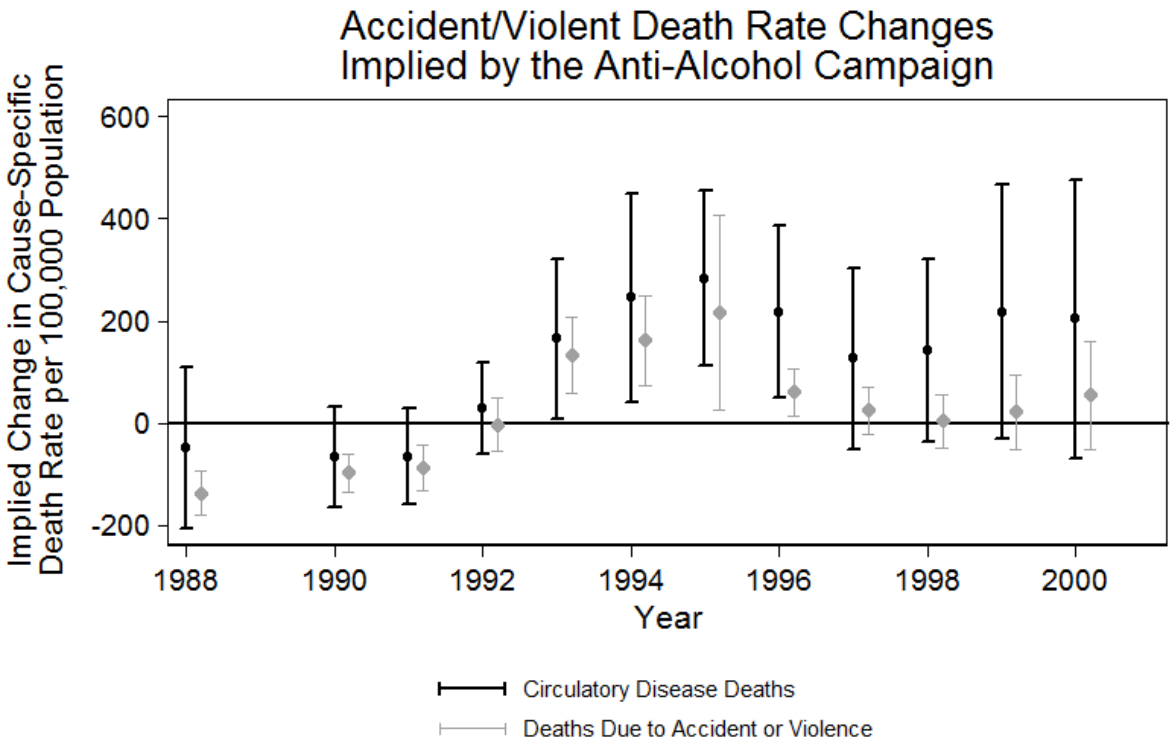
Campaign effects on crude death rate per 1,000 population plotted with 95% confidence intervals. Estimated coefficients for each year obtained through OLS estimation of equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. Coefficients scaled by median pre-campaign alcohol consumption to show implied change in crude death rate. All specifications include oblast and year fixed effects; standard errors clustered at the oblast level . All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, and 1988-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption using official alcohol sales supplemented by estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Figure 4



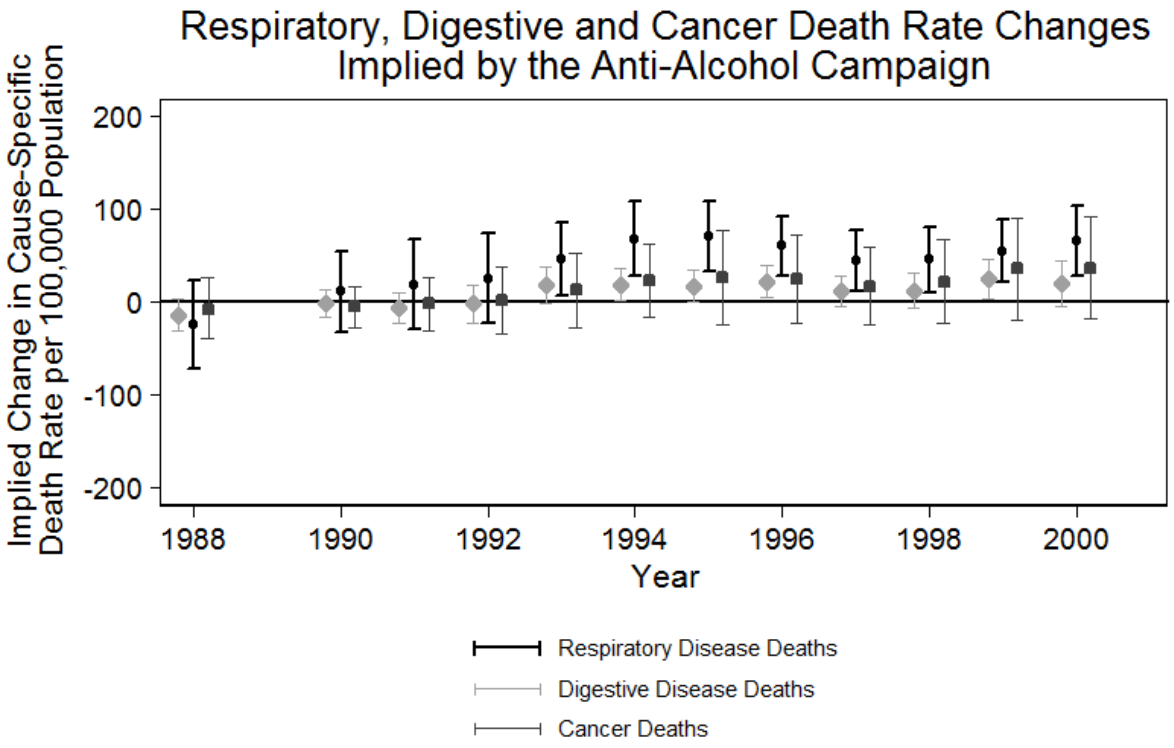
Campaign effects on crude death rate per 100,000 population plotted with 95% confidence intervals. Estimated coefficients for each year obtained through OLS estimation of equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. Coefficients scaled by median pre-campaign alcohol consumption to show implied change in crude death rate. All specifications include oblast and year fixed effects; standard errors clustered at the oblast level. All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, and 1988-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption using official alcohol sales supplemented by estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Figure 5a



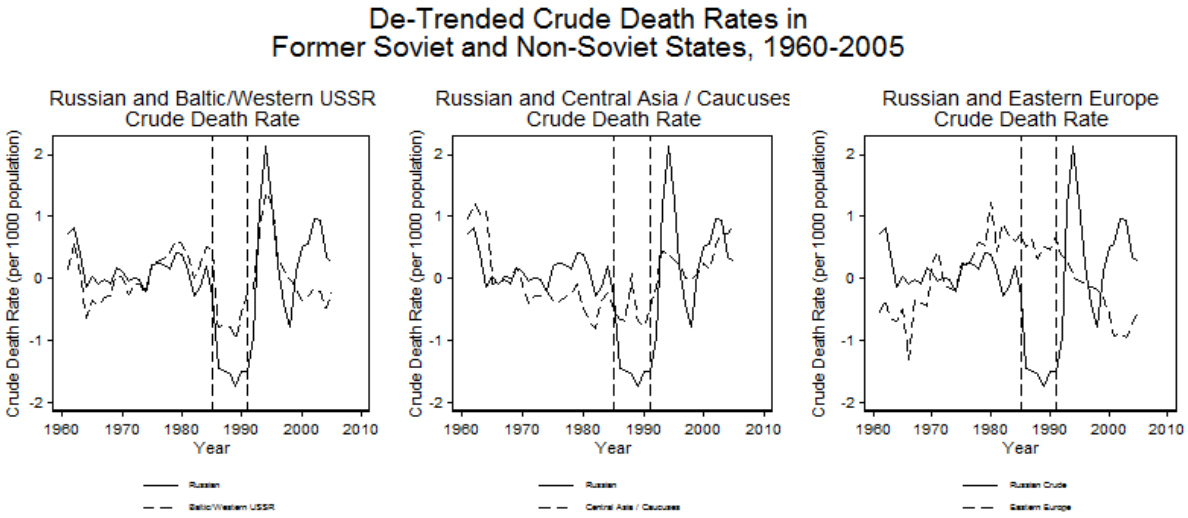
Campaign effects on crude death rate per 100,000 population plotted with 95% confidence intervals. Estimated coefficients for each year obtained through OLS estimation of equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. Coefficients scaled by median pre-campaign alcohol consumption to show implied change in crude death rate. All specifications include oblast and year fixed effects; standard errors clustered at the oblast level. All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, and 1988-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption using official alcohol sales supplemented by estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Figure 5b



Campaign effects on crude death rate per 100,000 population plotted with 95% confidence intervals. Estimated coefficients for each year obtained through OLS estimation of equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. Coefficients scaled by median pre-campaign alcohol consumption to show implied change in crude death rate. All specifications include oblast and year fixed effects; standard errors clustered at the oblast level. All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, and 1988-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption using official alcohol sales supplemented by estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Figure 6



Russian mortality data available from The Human Mortality Project (2011); other USSR mortality data from http://www.demoscope.ru; non-USSR mortality data from WDI.

TABLE 1:
DESCRIPTIVE STATISTICS

Years:	Pre-Campaign Years (Prior to 1985)		Campaign Years (1985-1989)		Transition Period (1990 -2000)		All Years	
	N	Mean	N	Mean	N	Mean	N	Mean
Crude Death Rate	219	10.27	306	10.42	955	13.04	1480	12.09
		(0.16)		(0.14)		(0.10)		(0.08)
Official Alcohol Sales	454	9.97	376	5.28	549	5.92	1379	7.08
		(0.11)		(0.16)		(0.08)		(0.08)
Total Alcohol Consumption	376	14.56	376	11.46	234	12.96	986	12.99
		(0.11)		(0.09)		(0.07)		(0.07)
Alcohol Poisoning Death Rate	73	29.46	151	9.91	864	26.43	1088	24.34
		(2.14)		(0.48)		(0.67)		(0.58)
Alcohol Poisoning Death Rate (Male)	73	46.54	151	15.92	864	41.47	1088	38.26
		(3.21)		(0.76)		(1.01)		(0.88)
Alcohol Poisoning Death Rate (Female)	73	12.38	151	3.89	864	11.39	1088	10.41
		(1.28)		(0.25)		(0.38)		(0.33)
Circulatory Disease Death Rate	77	509.63	78	555.92	959	675.92	1114	656.02
		(20.22)		(23.59)		(7.71)		(7.13)
Accident/Violent (and other External Cause) Death Rate	77	166.96	78	116.76	959	210.08	1114	200.57
		(5.54)		(3.08)		(2.28)		(2.15)
Respiratory Disease Death Rate	77	97.19	78	66.31	959	68.03	1114	69.93
		(4.08)		(3.30)		(0.82)		(0.83)
Digestive Disease Death Rate	77	28.42	78	28.69	959	37.40	1114	36.17
		(1.46)		(1.55)		(0.37)		(0.36)
Cancer Death Rate	77	142.76	78	167.93	959	181.14	1114	177.56
		(4.87)		(5.73)		(1.57)		(1.47)
Doctors Per Capita	258	3.03	423	4.39	959	5.38	1640	4.75
		(0.06)		(0.14)		(0.22)		(0.14)
Hospital Beds Per Capita	258	12.80	423	14.25	956	13.21	1637	13.41
		(0.18)		(0.12)		(0.09)		(0.07)
Emigration (in 1,000s)	--	--	--	--	800	38.64	800	38.64
						(0.93)		(0.93)
Immigration (in 1,000s)	--	--	--	--	800	38.64	800	38.64
						(0.99)		(0.99)
Privatized Manufacturing Employment Rate	--	--	--	--	894	0.53	894	0.53
						(0.01)		(0.01)
Average Monthly Income Per Capita (Deflated, in Rubles)	--	--	--	--	753	266.73	753	266.73
						(5.50)		(5.50)
Employment Per 1,000 Population	--	--	71	68.09	888	49.04	959	50.45
				(9.90)		(0.80)		(1.05)

Data on death rates, official alcohol sales, doctors, hospital beds, internal immigration and emigration, income, and employment are available in annual statistical yearbooks compiled by Goskomstat and Rosstat. We obtained this statistical yearbook data through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005), and Heleniak (2006) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research. Data on employment in private manufacturing are from Brown, Earle, and Gehlbach (2009) and Earle and Gehlbach (2010); data on emigration and immigration is from Andrienko and Guriev (2004). We constructed estimates of total alcohol consumption by extending the work of Nemtsov (2000) for estimating illegal alcohol production. See Appendices 1 and 2 for details. Crude death rate is per 1,000 population. Alcohol sales and consumption is liters per capita. Cause-specific death rates are per 100,000 population.

Table 2:
Pre-Campaign Alcohol Consumption and
Contemporaneous Drinking During the Anti-Alcohol Campaign

Dependent Variable:	**Total Alcohol Consumption**			
Pre-Campaign Alcohol Consumption × 1985	-0.280***	-0.129	-0.542*	-1.154***
	(0.092)	(0.091)	(0.294)	(0.143)
Pre-Campaign Alcohol Consumption × 1986	-0.580***	-0.323***	-0.849***	-1.524***
	(0.124)	(0.118)	(0.318)	(0.122)
Pre-Campaign Alcohol Consumption × 1989	-0.690***	-0.367**	-0.926***	-1.711***
	(0.109)	(0.171)	(0.318)	(0.079)
Pre-Campaign Alcohol Consumption × 1988	-0.683***	-0.292	-0.918***	-1.811***
	(0.122)	(0.208)	(0.336)	(0.059)
Pre-Campaign Alcohol Consumption × 1989	-0.619***	-0.197	-0.878***	-1.877***
	(0.097)	(0.285)	(0.309)	(0.043)
Additional Controls				
Per capita number of doctors			-0.020	-0.103***
			(0.054)	(0.033)
Per capita number of hospital beds			0.089	0.091
			(0.132)	(0.107)
Year Fixed Effects	Yes	Yes	Yes	Yes
Oblast Fixed Effects	Yes	Yes	Yes	Yes
Oblast-Specific Linear Trends	No	Yes	No	Yes
N	752	752	439	439
R^2	0.911	0.958	0.887	0.962

Data on official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research. Official alcohol sales augmented with estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details). Data sources for additional control variables available in Appendix 1. Table cells report OLS estimates obtained from equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Alcohol consumption measured in liters per capita. Oblast-year samples are restricted to years prior to 1990 (1970, 1978, 1980, 1985, 1986, 1988, and 1989) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

Table 3
Pre-Campaign Alcohol Consumption and Mortality

Alcohol Measure:	**Total Alcohol Consumption**				**Official Alcohol Sales**			
Dependent Variable:	**Crude Death Rate**				**Crude Death Rate**			
Campaign Year Interactions								
Pre-Campaign Alcohol Consumption × 1985	-0.199***	-0.144***	-0.226**	-0.064	-0.193***	-0.138***	-0.219**	-0.064
	(0.058)	(0.033)	(0.086)	(0.044)	(0.056)	(0.032)	(0.084)	(0.043)
Pre-Campaign Alcohol Consumption × 1986	-0.234***	-0.196***	-0.225***	-0.123**	-0.227***	-0.184***	-0.219***	-0.121**
	(0.057)	(0.065)	(0.057)	(0.061)	(0.056)	(0.062)	(0.055)	(0.059)
Pre-Campaign Alcohol Consumption × 1988	-0.306***	-0.241***	-0.322***	-0.150**	-0.293***	-0.225***	-0.315***	-0.149**
	(0.052)	(0.069)	(0.086)	(0.063)	(0.051)	(0.065)	(0.084)	(0.061)
Pre-Campaign Alcohol Consumption × 1989	-0.278***	-0.211**	-0.292***	-0.119	-0.265***	-0.194**	-0.282***	-0.117
	(0.054)	(0.085)	(0.090)	(0.078)	(0.053)	(0.080)	(0.088)	(0.075)
Crisis Year Interactions								
Pre-Campaign Alcohol Consumption × 1990	-0.213***	-0.144*	-0.234**	-0.060	-0.204***	-0.133*	-0.226**	-0.061
	(0.055)	(0.080)	(0.093)	(0.083)	(0.053)	(0.076)	(0.091)	(0.080)
Pre-Campaign Alcohol Consumption × 1991	-0.167**	-0.093	-0.174**	-0.027	-0.156**	-0.078	-0.163**	-0.025
	(0.072)	(0.072)	(0.083)	(0.080)	(0.071)	(0.069)	(0.081)	(0.078)
Pre-Campaign Alcohol Consumption × 1992	-0.034	0.047	-0.040	0.116	-0.032	0.052	-0.039	0.109
	(0.065)	(0.084)	(0.075)	(0.103)	(0.064)	(0.079)	(0.073)	(0.098)
Pre-Campaign Alcohol Consumption × 1993	0.131	0.221**	0.123	0.299***	0.125	0.218**	0.115	0.281***
	(0.099)	(0.093)	(0.110)	(0.106)	(0.095)	(0.087)	(0.106)	(0.100)
Pre-Campaign Alcohol Consumption × 1994	0.243*	0.340***	0.237*	0.425***	0.227*	0.328***	0.220*	0.397***
	(0.123)	(0.085)	(0.136)	(0.093)	(0.118)	(0.079)	(0.131)	(0.087)
Pre-Campaign Alcohol Consumption × 1995	0.324***	0.407***	0.306**	0.496***	0.306***	0.394***	0.287**	0.466***
	(0.118)	(0.107)	(0.124)	(0.100)	(0.113)	(0.100)	(0.119)	(0.097)
Pre-Campaign Alcohol Consumption × 1996	0.159*	0.245**	0.141	0.332***	0.145*	0.236**	0.126	0.307***
	(0.087)	(0.103)	(0.093)	(0.117)	(0.084)	(0.096)	(0.091)	(0.112)
Pre-Campaign Alcohol Consumption × 1997	0.028	0.116	0.010	0.203*	0.018	0.113	-0.000	0.181
	(0.095)	(0.105)	(0.100)	(0.116)	(0.092)	(0.098)	(0.097)	(0.112)
Pre-Campaign Alcohol Consumption × 1998	0.028	0.119	0.010	0.204	0.019	0.117	0.001	0.183
	(0.090)	(0.113)	(0.097)	(0.130)	(0.087)	(0.105)	(0.095)	(0.125)
Pre-Campaign Alcohol Consumption × 1999	0.129	0.222*	0.118	0.310**	0.112	0.211*	0.096	0.278**
	(0.137)	(0.121)	(0.145)	(0.127)	(0.133)	(0.113)	(0.140)	(0.122)
Pre-Campaign Alcohol Consumption × 2000	0.156	0.252*	0.148	0.344**	0.138	0.241*	0.125	0.311**
	(0.155)	(0.131)	(0.162)	(0.134)	(0.151)	(0.123)	(0.156)	(0.128)
Additional Controls								
Per capita number of doctors			-0.006	0.006			-0.006	0.005
			(0.013)	(0.010)			(0.013)	(0.009)
Per capita number of hospital beds			0.014	-0.042			0.012	-0.043
			(0.073)	(0.036)			(0.074)	(0.036)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast-Specific Time Trends	No	Yes	No	Yes	No	Yes	No	Yes
N	1,371	1,371	1,293	1,293	1,371	1,371	1,293	1,293
R^2	0.947	0.975	0.952	0.977	0.947	0.974	0.951	0.977

Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption by extending the work of Nemtsov (2000) for estimating illegal alcohol production (see Appendices 1 and 2 for details). Data sources for additional control variables available in Appendix 1. Table cells report OLS estimates obtained from equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Crude death rates are per 1,000 population. All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, 1988, and 1989-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

Table 4 Panel A
Pooled Estimates with Economic Controls - Transition Years

Alcohol Measure:	Total Alcohol Consumption			
Dependent Variable:	**Crude Death Rate**			
Transition Year Interactions				
Campaign Intensity × 1992	0.134***	0.146***	0.201***	0.233***
	(0.040)	(0.043)	(0.050)	(0.067)
Campaign Intensity × 1993	0.301***	0.332***	0.401***	0.495***
	(0.067)	(0.071)	(0.074)	(0.088)
Campaign Intensity × 1994	0.413***	0.458***	0.541***	0.672***
	(0.083)	(0.082)	(0.094)	(0.099)
Campaign Intensity × 1995	0.450***	0.549***	0.572***	0.748***
	(0.078)	(0.084)	(0.097)	(0.203)
Campaign Intensity × 1996	0.285***	0.383***	0.410***	0.619***
	(0.046)	(0.046)	(0.057)	(0.172)
Campaign Intensity × 1997	0.154***	0.251***	0.269***	0.530***
	(0.039)	(0.030)	(0.060)	(0.194)
Campaign Intensity × 1998	0.154***	0.250***	0.272***	0.583***
	(0.041)	(0.041)	(0.060)	(0.206)
Campaign Intensity × 1999	0.258***	0.350***	0.334***	0.699***
	(0.074)	(0.043)	(0.082)	(0.196)
Campaign Intensity × 2000	0.284***	0.377***		
	(0.087)	(0.052)		
Additional Controls				
Per Capita Number of Doctors			-0.001	-0.005
			(0.018)	(0.016)
Per Capita Number of Hospital Beds			0.004	-0.049
			(0.072)	(0.094)
Per Capita Immigration Rate			0.001	0.033
			(0.019)	(0.022)
Per Capita Emigration Rate			0.001	0.001
			(0.012)	(0.019)
Privatized Manufacturing Employment			-0.042	-0.167
			(0.284)	(0.266)
Employment per 1,000 population (%)			0.012	0.026**
			(0.014)	(0.013)
Real monthly income 1991 rubles			-0.001	0.000
			(0.000)	(0.001)
Year Fixed Effects	Yes	Yes	Yes	Yes
Oblast Fixed Effects	Yes	Yes	Yes	Yes
Oblast-Specific Time Trends	No	Yes	No	Yes
N	785	785	649	649
R^2	0.965	0.978	0.967	0.978

Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research. Official alcohol sales augmented with estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details). Data on private manufacturing employment available from Brown, Earle and Gehlback (2009) and Earle and Gehlback (2010). Data sources for additional control variables available in Appendix 1.Table cells report OLS estimates obtained from equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Crude death rates are per 1,000 population. All oblast-year samples are restricted to years prior to 2000 (1991-2000 for specifications including real monthly income and 1990-2000 for all other specifications) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

Table 4 Panel B
Pooled Estimates with Economic Controls - Transition Years

Alcohol Measure:	**Total Alcohol Consumption**							
Dependent Variable:	**Crude Death Rate**							
Transition Year Interactions								
Campaign Intensity × 1991	0.072	0.009	0.079	0.005	0.058	0.010	-0.005	0.025
	(0.070)	(0.026)	(0.083)	(0.025)	(0.063)	(0.024)	(0.023)	(0.023)
Campaign Intensity × 1992	0.206***	0.149***	0.214**	0.143***	0.201***	0.176***	0.171***	0.196***
	(0.077)	(0.036)	(0.090)	(0.039)	(0.073)	(0.045)	(0.045)	(0.049)
Campaign Intensity × 1993	0.373***	0.324***	0.384***	0.323***	0.372***	0.373***	0.345***	0.400***
	(0.095)	(0.064)	(0.109)	(0.066)	(0.093)	(0.075)	(0.064)	(0.070)
Campaign Intensity × 1994	0.485***	0.444***	0.498***	0.446***	0.498***	0.494***	0.462***	0.518***
	(0.109)	(0.075)	(0.124)	(0.079)	(0.118)	(0.095)	(0.090)	(0.087)
Campaign Intensity × 1995	0.535***	0.519***	0.547***	0.521***	0.553***	0.575***	0.523***	0.584***
	(0.093)	(0.081)	(0.101)	(0.080)	(0.096)	(0.079)	(0.073)	(0.070)
Campaign Intensity × 1996	0.370***	0.349***	0.382***	0.351***	0.377***	0.415***	0.343***	0.428***
	(0.066)	(0.038)	(0.080)	(0.039)	(0.069)	(0.038)	(0.037)	(0.047)
Campaign Intensity × 1997	0.239***	0.213***	0.250***	0.213***	0.241***	0.291***	0.201***	0.310***
	(0.073)	(0.026)	(0.087)	(0.025)	(0.076)	(0.029)	(0.042)	(0.037)
Campaign Intensity × 1998	0.239***	0.208***	0.250***	0.206***	0.237***	0.294***	0.207***	0.334***
	(0.067)	(0.042)	(0.082)	(0.041)	(0.069)	(0.041)	(0.044)	(0.045)
Campaign Intensity × 1999	0.341***	0.304***	0.356**	0.300***	0.346**	0.405***	0.274***	0.417***
	(0.125)	(0.029)	(0.146)	(0.032)	(0.134)	(0.058)	(0.080)	(0.066)
Campaign Intensity × 2000	0.368**	0.326***	0.387**	0.326***				
	(0.143)	(0.041)	(0.166)	(0.042)				
Additional Controls								
Per Capita Number of Doctors			0.003	0.004	-0.016	-0.018	0.002	-0.007
			(0.013)	(0.012)	(0.017)	(0.017)	(0.017)	(0.018)
Per Capita Number of Hospital Beds			-0.015	-0.062	0.039	-0.048	0.021	-0.048
			(0.072)	(0.063)	(0.064)	(0.066)	(0.065)	(0.079)
Per Capita Immigration Rate					-0.005	0.024	0.002	0.031
					(0.018)	(0.016)	(0.020)	(0.020)
Per Capita Emigration Rate					-0.012	0.004	-0.007	-0.000
					(0.012)	(0.008)	(0.013)	(0.015)
Privatized Manufacturing Employment							0.062	-0.096
							(0.303)	(0.269)
Employment per 1,000 population (%)							0.022***	0.026***
							(0.006)	(0.007)
Real monthly income 1991 rubles								
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast-Specific Time Trends	No	Yes	No	Yes	No	Yes	No	Yes
N	865	865	855	855	751	751	736	736
R^2	0.965	0.979	0.964	0.979	0.968	0.979	0.969	0.979

Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research. Official alcohol sales augmented with estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details). Data on private manufacturing employment available from Brown, Earle and Gehlback (2009) and Earle and Gehlback (2010). Data sources for additional control variables available in Appendix 1.Table cells report OLS estimates obtained from equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Crude death rates are per 1,000 population. All oblast-year samples are restricted to years prior to 2000 (1991-2000 for specifications including real monthly income and 1990-2000 for all other specifications) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

The Gorbachev Anti-Alcohol Campaign and Russia's Mortality Crisis

BY Jay Bhattacharya, Christina Gathmann, and Grant Miller*

Online Appendices

Appendix I: Data

This appendix describes the sources used to construct our new oblast-year panel data set spanning 1970-2000 that includes mortality rates, official alcohol sales, alcohol prices, alcohol production, and socio-economic and demographic characteristics. We use the term "oblast" throughout, but geographic areas also include several krais (Altaiskii, Krasnodarskiy, Krasnoyarskii, Khabarovskii, Primorskii, Stavropolski) and autonomous republics (Altai, Bashkortostan, Buryatiya, Chuvash, Dagastan, Kabardino-Balkarskaya, Kalmykaya, Karachaevo-Cherkesskaya, Karelia, Khakasiya, Komi, Marii-El, Mordovaya, North Osetiya-Alaniya, Sakha, Taatarstan, Tuva, Udmurtskaya). We exclude autonomous okrugs (Aginsky, Eventsky, Chukotsky, Khanty-Mansiisk, Komi-Permiatsky, Koryaksky Nenets, Nenetsky, Taimyrskii (or Dolgano-Nentsky), Usy-Ordynsky, Yamalo-Nenetsky) from the analysis because we do not have information about them for several key years. Overall, our analyses therefore generally include 77 oblasts (including krais and republics).

From the 1960s until 1986, statistics on deaths, alcohol production/consumption, and crime were collected but not made publicly available for political purposes. Under Glasnost and Mikhail Gorbachev's leadership, however, the Central Statistical Office of the Soviet Union (*Goskomstat*) resumed publication of oblast-level mortality statistics in annual demographic yearbooks in 1986 (publication of official alcohol sales data and crime statistics resumed shortly thereafter – in 1987 and 1988, respectively). Since the 1980s, an estimated 94% of all deaths in Russia have been medically certified (with the remainder certified by trained paramedics called *feldshers*) (Shkolnikov et al. 1996). Oblast governments then use these death records to construct oblast-level mortality statistics by age, sex, and cause. In principle, these oblast-year statistics are available from *Goskomstat* (and its successor *Rosstat*). Obtaining these records is not easy in practice, so we also conducted a comprehensive search of all Russian and English language publications with statistics on mortality, alcohol, and crime in constructing our data set.

A. Vital Statistics

Our primary dependent variable is the crude death rate (CDR), which is defined as the number of deaths per 1,000 people. The CDR is calculated as the number of deaths from all causes in a calendar year divided by the mid-year *de facto* population (the official inter-censual population estimate) and is available for years 1970, 1978, 1980, 1985, 1986, and 1988-2000 (Goskomstat SSSR 1987; New World Demographics 1992; Goskomstat Rossii 1992; 1993a; 1995; 1996b-2005b).

We also study death rates (per 100,000 population) by several categories of causes. In the Soviet Union, cause-specific deaths were reported using a Soviet classification system containing 175 categories. These were later reclassified according to the World Health

Organization's International Classification of Diseases (ICD) (see below). Given the focus of our study, an important cause of death is alcohol poisoning (a marker for a broader set of alcohol-related deaths). The Soviet Union and Russian Federation require that sudden, unexpected deaths be investigated (by autopsy). Cases of alcohol poisoning are identified when blood alcohol concentrations exceed 250 mg/dl and in the absence of other apparent causes. Alcohol poisoning deaths are reported separately for men and women and are available for years 1978/9 and 1988-2000. These data were graciously provided by Vladimir Shkolnikov. To convert alcohol poisoning deaths (which are reported by age group for years 1989-2000) into overall death rates (per 100,000), we use the 1998 European Standard Population. Alcohol poisoning death rates are then the weighted average of the age-specific rates (using standardized population shares as weights).

In addition to alcohol poisonings, we study data on deaths by other major causes: neoplasms/cancers (group 2, codes 140-239), circulatory diseases including cardiovascular diseases (group 7, codes 390-459), acute respiratory infections (group 8, codes 460-519), diseases of the digestive system (group 9, codes 520-579) and accidental/violent deaths (accidents, other poisonings, homicide, and suicide (group 17, codes 800-999). About half of deaths in the last category are thought to be alcohol-related (Nemtsov 1998; 2000). These data are available for 1978/8, 1988/9 and annually since 1990 (Goskomstat Rossii 1993b; Goskomstat Rossii 1996b-2005b; Vallin et al. 2005).

Evaluations of Russia's mortality statistics generally conclude that they are acceptable in quality with relatively little under-reporting. Exceptions are Tuva and regions in the North Caucasus (Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai) where studies of infant mortality under-reporting suggest rates as high as 25% during the 1980s (Blum and Monnier 1989). The cause of death statistics appear somewhat less reliable as many alcohol related deaths seem to be classified as cardiovascular disease or cause unknown (Andreev 1999, Gavrilova et. al. 2005, Zaridze et al. 2009).

Between 1969 and 1991, the Soviet cause-of-death classification system was changed three times (in 1970, 1981 and 1988). The Soviet system from 1965 to 1970 was similar to WHO ICD-8 codes, and the revisions in 1981 and 1988 closely resembled WHO ICD-9 codes (Goskomstat created a key matching the two) (Shkolnikov et al. 1996). The analyses of Vallin et al. (1996) suggest that the changes in 1970 and 1981 did not influence the registration of deaths from major causes (at least at ages up to age 65) (Vallin et al. 1996). The 1988 revision simply merged the previous classification's 'employment-related' and 'non-employment-related' alcohol poisoning subgroups into a single category. A comparison of data from Russia and the three Baltic countries (Estonia, Latvia, and Lithuania which shifted before 1999) shows no discontinuity, suggesting that data before and after the coding change are roughly comparable (Mesle et al. 1996).

B. Population Measures

Population estimates used to convert deaths into death rates are based on the Soviet censuses of 1970, 1979, and 1989 Soviet censuses and the 2002 census of the Russian

Federation. These censuses were conducted on January15, 1970; January17, 1979 and 1989; and between October 9 and 16, 2002. Using census population counts, *Goskomstat* produced official population estimates for January 1 of each census year. For inter-census years, oblast statistical offices estimated their populations using information on births and deaths as well. Population estimates were also adjusted using data on internal migration collected by the Ministry of the Interior. Mid-year *de facto* populations used as denominators for constructing rates are calculated as arithmetic means of population estimates at the beginning of a given year and the subsequent year (Goskomstat SSSR 1990; New World Demographics 1992; Goskomstat Rossii 1993c; Goskomstat 1996a-2005a).

C. Alcohol Sales

As a monopolist, the government of the Soviet Union decided official alcohol production, pricing, foreign trade, and domestic distribution. *Goskomstat* collected statistics on alcohol sales from reports of government retail trade networks across the country (but do not alcohol sold on military bases). After Russia's political and economic transition, *Rosstat* continued collecting data in the same way, although data after 1992 do not include legal private trade and restaurant sales. More importantly, official sales statistics also do not include illegal home production of alcohol (*samogon*).

Data on official sales are reported in billions of rubles and in volume of pure alcohol for years 1970, 1980, 1985 and 1989. In addition, official sales data are reported in liters of pure alcohol per person for 1970, 1980, 1984, 1985 and 1989-1992. We also have information on sales of specific types of alcoholic beverages (vodka, wine, beer, champagne, and cognac). The numbers for individual beverages sales are reported in liters per person and are available for years 1970, 1980-1992, and 1997-2000. Sales data for cognac and champagne were available since 1999 only. We converted the sales data for specific types of beverages into total sales of pure alcohol using the following assumptions about alcohol concentrations for each type of beverage (from Andrienko and Nemtsov 2006): Russian vodka 40%; wine 14.4%; cognac 18%; champagne 22.8%; beer 2.85% (before 1995), 3.37% (between 1995 and 1999), and 3.85% (after 2000). To summarize, we calculate alcohol consumption per capita in liters of pure alcohol from sales of different types of alcoholic beverages using the following formula:

$$\textit{Liters of Pure alcohol} = 0.144*\textit{wine} + 0.4*\textit{vodka} + 0.228*\textit{champagne} + 0.18*\textit{cognac} + 0.285*\textit{beer}*1(1970\text{-}1994) + 0.337*\textit{beer}*1(1995\text{-}1999) + 0.389*\textit{beer}*1(2000\text{-}2005).$$

We thus generate a panel of oblast-level total alcohol sales data from 1970 to 2000 (with data missing between 1971 and 1979). The data prior to 1997 (when both official sales and sales of specific beverages types are reported) show that our calculations using beverage-specific data closely matches the *Goskomstat* official data on pure alcohol sales.

D. Alcohol production and prices

The government controlled alcohol production and prices which were set by the administration and not determined by market forces during the Soviet regime. The most

comprehensive information on production is available for vodka which is also the most popular beverage in Russia. Data on vodka production are reported in 1,000 liters for 1970, 1979, 1980, 1985 and 1990-2000 (Goskomstat Rossii 1993a; 1998g; 2000g; 2002g; 1999h-2004h; TsCU SSSR 1971; 1980). In addition, we have information on production of pure alcohol in rubles per person for 1989-1992, 1994, 1995, 1997 and 1999-2000 (Goskomstat SSSR 1989b; Goskomstat Rossii 1993a; 1995a; 1997f; 1998f; 1999h-2004h). We use the oblast-specific share of vodka production in total alcohol production in 1990 to construct vodka production in 1989 (from information on pure alcohol production).

Alcohol prices are available at the oblast level only following Russia's political and economic transition. Specifically, we have annual information about the price of a liter of domestic vodka at the end of year beginning in 1992 (Goskomstat Rossii 1996c; 1996d; 1997e; 1998e; 2002c; 2006c). For earlier years, we calculate alcohol prices using information on official alcohol sales and production. For alcohol sales, we have data in liters per person and rubles for years 1970, 1980, 1985, and 1989. In addition, we have data on alcohol production both in 1,000 liters and rubles per person for 1999-2000. We then calculate the price of a liter of pure alcohol between 1970 and 1989 by dividing total sales in rubles by the total quantity sold (or produced). Similarly, we calculate the price of pure alcohol after 1999 by multiplying total alcohol production in rubles per person by the oblast population and then dividing by total alcohol produced (in liters).

E. Other Covariates

To control for other factors influencing mortality in Russia, we assembled oblast-year data on employment, income, health care infrastructure, fertility, and migration. Employment is measured as the number of people employed per 1000 population and is available for 1985 and all years beginning in 1990 (Goskomstat Rossii 1997f, 2002j, 2006j). We also use data on the share of employment in private manufacturing, which is available for all years beginning in 1992 (Brown, Earle and Gehlbach 200, Earle and Gehlbach 2010). Income is measured as average income per month in real Rubles and is available for years 1970, 1980, 1985, 1989-1992, and all years beginning in 1994 (Goskomstat Rossii 1992, 1993a, 1996a-2005a, Treml and Alexeev 1993). Our health care infrastructure and workforce measures are the number of hospital beds per capita and the number of doctors per capita; these variables are available for years 1970, 1975, 1980 and all years beginning in 1985 (Goskomstat Rossii 1994, 1997f-2001f, 2002i-2005i, Goskomstat SSSR 1990b). Crude birth rate data (defined as the number of births per 1,000 population) is available for years 1970, 1980, 1985-1986, and all years beginning in 1988 (Goskomstat SSSR 1987, Goskomstat Rossii 1992, 1993a, 1995, 1996b-2005b, New World Demographics 1992). Finally, data on immigration and emigration flows are available for all years beginning in 1989 (Andrienko and Guriev 2004, Goskomstat SSSR 1990a, Goskomstat Rossii 1993b, 1995, 2002i-2005i).

Additional Data Source References:

Gavrilova Natalia S., Victoria G. Semyonova, Galina N. Evdokushkina, Alla E. Ivanova, and Leonid A. Gavrilov. 2005. "Problems with Mortality Data in Russia." Paper presented at the Population Association of America Annual Meeting, Philadelphia, PA.

Goskomstat Rossii. 1992. *Pokazateli sotsial'nogo razvitiia respublik, kraev i oblasteĭ Rossiĭskoĭ Federatsii*. Moscow: Goskomstat.

Goskomstat Rossii. 1993a. *Pokazateli sotsial'nogo razvitiia respublik, kraev i oblasteĭ Rossiĭskoĭ Federatsii*. Moscow: Goskomstat.

Goskomstat Rossii. 1993b. *Demograficheskii Ezhegodnik Rossii*. Moscow: Goskomstat.

Goskomstat Rossii. 1993c. *Rossiĭskaia Federatsiia v 1992 godu*. Moskow: Goskomstat.

Goskomstat Rossii. 1994. *Rossiĭskiĭ Statisticheskiĭ Ezhegodnik: statisticheskiĭ sbornik*. Moscow: Goskomstat.

Goskomstat Rossii. 1995. *Demograficheskii Ezhegodnik Rossii*. Moscow: Goskomstat.

Goskomstat Rossii. 1995a-2005a. *Rossiiskii statisticheskii ezhegodnik,* Moscow: Goskomstat.

Goskomstat Rossii. 1996b-2005b. *Demograficheskii Ezhegodnik Rossii*. Moscow: Goskomstat.

Goskomstat Rossii. 1996c, 2002c, 2006c. *Tseny v Rossii : statisticheskiĭ sbornik*, Moscow: Goskomstat.

Goskomstat Rossii. 1996d. *Srochnoe Soobshchenie ob izmenenii tsen na prodovolstvennie tovari posostoyaniyu na 30 dek 1996*, Moscow: Goskomstat.

Goskomstat Rossii. 1997e-1998e. *Srednie ts eny na prodovolstvennie tovary v dekabrya.* Moscow: Goskomstat.

Goskomstat Rossii. 1997f-2001f. *Regiony Rossii*, Moscow: Goskomstat.

Goskomstat Rossii. 1998g, 2000g, 2002g. *Promyshlennost' Rossii: statisticheskii sbornik*. Moscow: Goskomstat.

Goskomstat Rossii. 1999h-2004h. *Proizvodstvo i oborot etilovogo spirta i alkogol'noi produktsii v Rossiiskoi Federatsii*. Moscow: Goskomstat.

Goskomstat Rossii. 2002i-2005i. *Regiony Rosii. Sotsial'no-ekonomicheskie pokazateli***,** Moscow: Goskomstat.

Goskomstat Rossii. 2002j, 2006j. *Ekonomicheskaia aktivnost' naseleniia Rossii*. Moscow: Goskomstat.

Goskomstat SSSR. 1987. *Naselenie SSSR*, Moskow: Finansy i statistika.

Goskomstat SSSR. 1990a. *Demograficheskii Ezhegodnik SSSR*. Moscow: Goskomstat.

Goskomstat SSSR. 1989b-1990b. *Narodnoe khoziaistvo SSSR: statisticheskii ezhegodnik*, Moscow: Goskomstat.

TsCU SSSR. 1971. "Otchet o proizvodstve produktsii pishchevoi promyshlennosti po formam podchineniya, posoyuznym respublikam, oblastyam, krayam, ASSR za 1970 god (itogi raztabotki godovykh otchetov promyshlennykh predpritatii), Tom I." Moscow.

TsCU SSSR. 1980. "Svodnyi otchet no itogam razrabotki godovykh otchetov promyshlennostikh predpriyatiyakh vyrazhenii po SSSR, ministerstvam, formam podchineniya, soyuznym respublikam, ekonomicheskim rayonam, oblastyam, krayam, ASSR za 1979 god." Moscow.

Appendix II: Estimation of Total Alcohol Consumption (Official Alcohol Sales and *Samogon* Production)

Official alcohol sales data measure sales of state-produced alcoholic beverages. However, anecdotal evidence suggests that illegal production of alcoholic beverages – especially *samogon* – increased during the Gorbachev Anti-Alcohol campaign. Because comprehensive oblast-year estimates of illegal alcohol production are not available, we extended the work of Nemtsov (2000) to estimate illegal alcohol production and consumption for the 1980s and early 1990s.

Nemtsov (1998, 2000) developed two indirect methods for estimating illegal alcohol consumption. First, Nemtsov (1998) exploits the fact that sugar is the main ingredient required for *samogon* production. For Moscow prior to 1986 (when the Soviet Union began to ration sugar), he used sugar sales data to estimate excess sugar sales by subtracting standard dietary requirements of sugar from total sugar sales.[1] Excess sugar sales are then converted into *samogon* production estimates with information about the sugar concentration of *samogon*.

To estimate samogon production for years after 1986, Nemtsov (2000) used forensic records to develop a second indirect technique. Both the Soviet Union and the Russian Federation require each oblast's forensic bureau to perform autopsies for all violent and accidental deaths as well as for deaths with unclear causes. All autopsies report blood alcohol content, effectively providing a non-random sample of Russians with measures of alcohol concentration in the blood. Nemtsov (2000) calculates the ratio of autopsies with positive blood alcohol content (excluding alcohol poisoning deaths) to the number of autopsies with no blood alcohol content and parametrically relates this ratio to total alcohol consumption. He then uses this estimated parametric relationship to predict total (including illegal) alcohol consumption for 25 oblasts between 1980 and 1992, allowing him to recover implied *samogon* consumption (Nemtsov 2000).[2] Autopsy-based estimates closely match sugar-based estimates for Moscow between 1983 and 1986 and outperform other methodologies (based on hospital admissions for alcohol-induced psychosis, cirrhosis deaths, and pancreatitis deaths, for example) (McKee 1999, Nemtsov 2000, Balan-Cohen 2007).

To generate oblast-year estimates of total alcohol consumption for key years in our data set, we use statistical relationships between official alcohol sales and estimated *samogon* consumption reported in Nemtsov (2000). Specifically, Nemtsov (2000) uses data from 25 oblasts in 1990 to regress *samogon* consumption on official alcohol sales, estimating the following relationship: *samogon* = 12.38 – 1.02×official sales. He also reports the correlation coefficient between official sales (OS) and *samogon*/illegal alcohol (IA) for years 1983, 1985 and 1990. Because the regression slope is equal to Cov(IA,OS)/(Var(OS)) and the correlation coefficient $r = Cov(IA,OS)/(Var(IA)^{1/2}\times(Var(OS)^{1/2})$, we can use the observed variance of

[1] Nemtsov (1998) uses the minimum amount of sugar sold (per person and month) in the state retail network during the period 1983 to 1986. The figure he uses – 24.3 kg of sugar (recorded for September of 1985) – is close to the average sugar consumption (24 kg) in the Soviet Union as reported by the Institute of Nutrition of the Soviet Union in the Academy of Medical Sciences.

[2] These oblasts were Altai krai, Amur, Bashkiria, Ekaterinburg, Ivanova, Khabarovsk, Kaluga, Karelia, Kemerov, Kursk, Leningrad, Moscow city, Moscow oblast, Murmansk, Novgorod, Novosibirsk, Omsk, Orel, Rostov, Samara, Saratov, Sakhalin, St. Petersburg city, Yaroslav.

official sales in 1990 to calculate the implied variance of *samogon* production in 1990. Assuming the variance of *samogon* production to remain constant over time, we then use the observed variance of official sales in 1983 and 1985 to calculate implied regression coefficients for years 1983 and 1985. We assign the slope in 1983 to pre-campaign years 1980-1984, the 1985 slope to campaign years 1985-1989, and the 1990 slope to post-campaign years 1990-1992.

We then calculate year-specific regression constants. To do so, we subtract observed annual national-level official alcohol sales from annual national-level total alcohol consumption reported by Nemtsov (2000), yielding annual national-level *samogon* consumption. With observed official alcohol sales and annual *samogon* consumption, we are then able to calculate implied year-specific regression constants.

Finally, we use these year-specific regression constants and slopes together with our oblast-year data on official alcohol sales to predict oblast-year *samogon* consumption. We then calculate total alcohol consumption as the sum of official sales and *samogon* consumption for years 1980-1992. To validate these predictions, we calculate mean total consumption for the same 25 oblasts studied in Nemtsov (2000), and we then compare annual means with those provided by Nemtsov (2000) for Russia's six regions (North and Northwest Region, Central Region, Northern Caucasus Region, Urals and Volga Region, Western Siberia Region, and Russian Far East Region). Appendix Table 4 shows that our calculations generally match these published figures.

Appendix III: Estimation and Simulation of the Temporal Relationship between Alcohol Consumption and Mortality in the Framingham Heart Study

Many consequences of alcohol consumption occur over time. Specific examples include cirrhosis, hypertension, heart attacks, and strokes. There are suggestive reports that moderate alcohol consumption may increase longevity as well. However, given the magnitude of the decline in alcohol consumption under the Gorbachev Anti Alcohol Campaign, we would expect a reduction in mortality on balance. Similarly, we hypothesize that the relaxation of constraints to drinking at the end of the campaign increased mortality. The precise temporal relationship between contemporaneous alcohol consumption and subsequent mortality is unclear, however.

The objective of this appendix is to examine this temporal relationship with data from the Framingham Heart Study, a large longitudinal study uniquely suited for this purpose.

A. The Framingham Heart Study

Spanning 1948 to the present, the Framingham Heart Study has collected unusually detailed high-frequency cohort health data from three generations of individuals. At its inception, the study enrolled 5,209 randomly selected subjects from the population of Framingham, Massachusetts. Sampling children of the original participants, it then added an additional cohort of 5,124 individuals (and their spouses) in 1971 and a third generation of grandchildren (and their spouses) in 2002. Our analyses use individuals from the first cohort observed during years 1948-2000.

Investigators visit each member of all three cohorts every two years to administer a detailed questionnaire and medical examination. The study follows every participant until death, using death certificates to verify dates of death. Beginning with the seventh wave (which was conducted between 1960 and 1964), the study began collecting information about alcohol consumption. Specifically, the questionnaires ask respondents how many cocktails, glasses of beer, and glasses of wine (with a standard drink size specified) they consumed during the past month.

Using responses to these questions, we computed total alcohol consumption (grams per day) by multiplying the number of each type of drink consumed with its average alcohol content (and summing across the three products). Following the Framingham investigators, we define a standard drink to be 13.7 grams (0.018 liters) of pure alcohol. This amount of pure alcohol is found in 12-ounces (0.36 liters) of beer, 5-ounces (0.15 liters) of wine, or 1.5-ounces (0.04 liters) of 80-proof liquor such as gin, rum, vodka, or whiskey. We adjust for changes during the late 1960s in the alcohol content of liquor (from 100% to 80% proof), the type of wine consumed (from fortified to table wine), and changes in average serving sizes in calculating total ethanol consumption. Between waves, we impute alcohol consumption at the level reported in the preceding wave.

The Framingham Heart Study provides an excellent source of information about alcohol consumption and mortality and is distinguished from other longitudinal data sets by its longevity

and data quality. Hence, the Framingham Heart Study is well suited for estimating the temporal relationship between alcohol consumption and subsequent mortality.

B. Estimation

Our analysis proceeds as follows. Let $i = 1 \ldots N$ denote each of the N distinct individual in the study, let $k = 1 \ldots K$ represent the wave in which the individual is interviewed. Individual i is surveyed first at age_{i0} years old, and then at $age_{i1} \ldots age_{iK}$ assuming that the individual survives to those ages. While interview waves were generally separated by two years, there was considerable variation in exact interview dates, and the survey was fielded every single calendar year after the start of the study. The Framingham sample cohort at wave 1 consists entirely of adults over the age of 28.

Let t_{ik} be the time elapsed between initial entry into the study and wave k. We normalize $t_{i1} = 0$ for each individual. Let $dead_i$ be the date (measured relative to t_1) that individual i dies if he/she dies during the observation period, and let $dead_i = \infty$ if the individual does not die during the observation period. So an individual will not be observed in wave k if $t_{ik} > dead_i$.

Let $alc_{it} = \{none_{it}, light_{it}, moderate_{it}, heavy_{it}\}$ represent a vector of mutually exclusive and collectively exhaustive dummy 1rvariables indicating computed alcohol consumption category. We assign these dummies based on the amount of alcohol that individual i reports drinking at time t over the previous four weeks. We assign $none_{it} = 1$ to individuals reporting no alcohol consumption over the past month, $light_{it} = 1$ to individuals in the 0-25th percentiles of the alcohol consumption distribution (measured in grams of alcohol conditional on positive consumption), $moderate_{it} = 1$ to individuals in the 0-25th percentiles of the alcohol consumption distribution (measured in grams of alcohol conditional on positive consumption), and $heavy_{it} = 1$ to people above the 75th percentile. In addition to alcohol consumption, we observe education ($educ_{it}$), which we divide into six mutually exclusive groups: 8th grade or less, some high school, high school graduate, some college, college graduate, and post-graduate. We also observe the sex of the respondent, coded as a dummy variable, $male_i$.

Appendix Table 5 shows means and standard deviations of our key variables in waves 1, 7 (the first wave asking alcohol consumption questions), 17, and 23. In the initial wave, there were 5,209 individuals in the cohort. As the sample ages, the number people in the sample decreases, due mainly to deaths. The proportion of females increases at successive ages because males have higher mortality rates at these ages. The proportion of the population that never attended high school decreases substantially over time because those with lower educational attainment have higher mortality hazards. In wave 7, 59% of the population reported some alcohol consumption during the preceding month; 17% reported heavy drinking (that is $heavy_{it} = 1$). By wave 23, the proportion of the cohort reporting some alcohol consumption falls to 39%, and the share of heavy drinkers drops to 7%. This is due to both differential mortality (as we will show) and less drinking with age.

We first estimate a Cox proportional hazards model of the determinants (including alcohol consumption) of time to death from entry into the study. Let $\lambda_i(t)$ be the hazard rate of mortality for individual i at time t. We model the mortality hazard as follows:

$$\lambda_i(t) = \lambda_0(t)exp(\beta_1 age_{it} + \beta_2 educ_{it} + \beta_3 male_i + \beta_4 alc_{it}) \quad (1)$$

Here, $\lambda_0(t)$ is the baseline hazard rate. Appendix Table 6 shows the coefficient estimates (and robust standard errors) from the Cox proportional hazards regression. The results are intuitive. Males face a substantially higher mortality hazard than females, with a hazard ratio greater than 1.5; each year of age increases the hazard rate by about 8 percent. Those with education beyond high school have lower mortality hazards. Finally, heavy drinking increases the mortality hazard by about 11 percent relative to complete abstention. Mild or moderate drinking is associated with a lower but statistically insignificant mortality hazard.

C. Simulation Analysis

We next use estimates from the Cox model above to conduct simulation analyses. Specifically, we analyze temporal patterns of mortality rates for three different counterfactual scenarios. *Scenario 1*: we study the evolution of mortality rates over time following a hypothetical change from heavy drinking to abstention in the entire population. *Scenario 2*: we model an event analogous to the Gorbachev Anti-Alcohol Campaign in which heavy drinkers become light drinkers and moderate and light drinkers abstain from drinking for five years. At the end of the five-year "campaign" period, all individuals return to their previous alcohol consumption path. *Scenario 3*: we repeat scenario 2 but also include a temporary two-year increase in alcohol consumption (to levels above the path prior to the campaign) at the end of the "campaign." During these two years, previously heavy drinkers return to heavy drinking, previously moderate drinkers become heavy drinkers, previously light drinkers become moderate drinkers, and previous abstainers become light drinkers.

Formally, let $\widehat{alc}_{it}^{j}$ be the j^{th} counterfactual path of alcohol consumption followed by individual i. Using our estimates and equation (1), we calculate the mortality hazard path predicted by the counterfactual alcohol consumption path:

$$\hat{\lambda}_i^j(t) = \hat{\lambda}_0(t)exp\left(\hat{\beta}_1 age_{it} + \hat{\beta}_2 educ_{it} + \hat{\beta}_3 male + \hat{\beta}_4 \widehat{alc}_{it}^{j}\right) \quad (2)$$

$\hat{\lambda}_i^j(t)$ is the predicted mortality hazard path for the j^{th} counterfactual alcohol consumption path, $\hat{\lambda}_0(t)$ is the observed baseline hazard function, and $\hat{\beta}_1 \ldots \hat{\beta}_4$ are the Cox regression coefficient estimates.

To simulate the three scenarios that we describe above, we need predictions for four counter-factual paths. We need four counter-factual paths for three scenarios because *Scenario* 1 compares two distinct counter-factual paths, while *Scenarios 2* and *3* use one counter-factual path each and compare against the actually observed mortality path. For $j = 1$, we set $\widehat{alc}_{it}^{1}$ such

that $\widehat{none}_{it}^{1} = 1 \; \forall i, t$.[3] For $j = 2$, we set $\widehat{alc}_{it}^{2}$ such that $\widehat{heavy}_{it}^{2} = 1 = 1 \; \forall i, t$. For $j = 3$ and $j = 4$, we set $\widehat{alc}_{it}^{3}$ and $\widehat{alc}_{it}^{4}$ according to Appendix Table 7:

The j^{th} counterfactual survivor function for individual i implied by this hazard rate formula is:

$$S_i^j(t) = exp\left(-\int_0^t \hat{\lambda}_i^j(u)du\right) \tag{3}$$

We calculate a discrete version of (3) for each individual in the population and for each counterfactual path.

For our simulations, we draw $k = 1 \ldots K$ independent uniform random numbers, $z_{ik} \sim U[0,1]$, for each individual in the population. k counts over the number of iterations in our simulation, and we set $K = 1{,}000$. For a given iteration, we calculate the time of death in the simulation for each individual as follows:

$$dead_{ik}^j = \inf\{t | S_i^j(t) \leq z_{ik}\} \tag{4}$$

It should be clear that $\lim_{\epsilon \to 0} P\left(t < dead_{ik}^j < t + \epsilon\right) = S_i^j(t) \; \forall k$.

Using draws of time to death, we calculate the number of people who die in each year, $d_k^j(t)$, as well as the size of the cohort alive, $pop_k^j(t)$:

$$d_k^j(t) = \sum_{i=1}^{N} 1\left(t < dead_{ik}^j < t + 1\right) \tag{5}$$

$$pop_k^j(t) = \sum_{i=1}^{N} 1\left(dead_{ik}^j > t\right) \tag{6}$$

Here, $1(.)$ is the indicator function. The death rate in year t is:

$$rate_k^j(t) = \frac{d_k^j(t)}{pop_k^j(t)} \tag{7}$$

From our four counterfactual paths, we examine the effect on the time path of the mortality for each of our three thought experiments. We calculate the following quantities:

$$\text{effect}_1(t) = \underset{k}{\text{median}}\{rate_k^1(t) - rate_k^2(t)\} \tag{8}$$

[3] $\widehat{none}_{it}^{1} = 1$ is a shorthand notation here for $\widehat{alc}_{it}^{1} = \left\{\widehat{none}_{it}^{1} = 1, \widehat{light}_{it}^{1} = 0, \widehat{moderate}_{it}^{1} = 0, \widehat{heavy}_{it}^{1} = 0\right\}$. We use similar shorthand throughout the remainder of this appendix.

$$\text{effect}_2(t) = \underset{k}{\text{median}}\{rate_k^3(t) - rate_k(t)\}$$

$$\text{effect}_3(t) = \underset{k}{\text{median}}\{rate_k^4(t) - rate_k(t)\}$$

D. Results

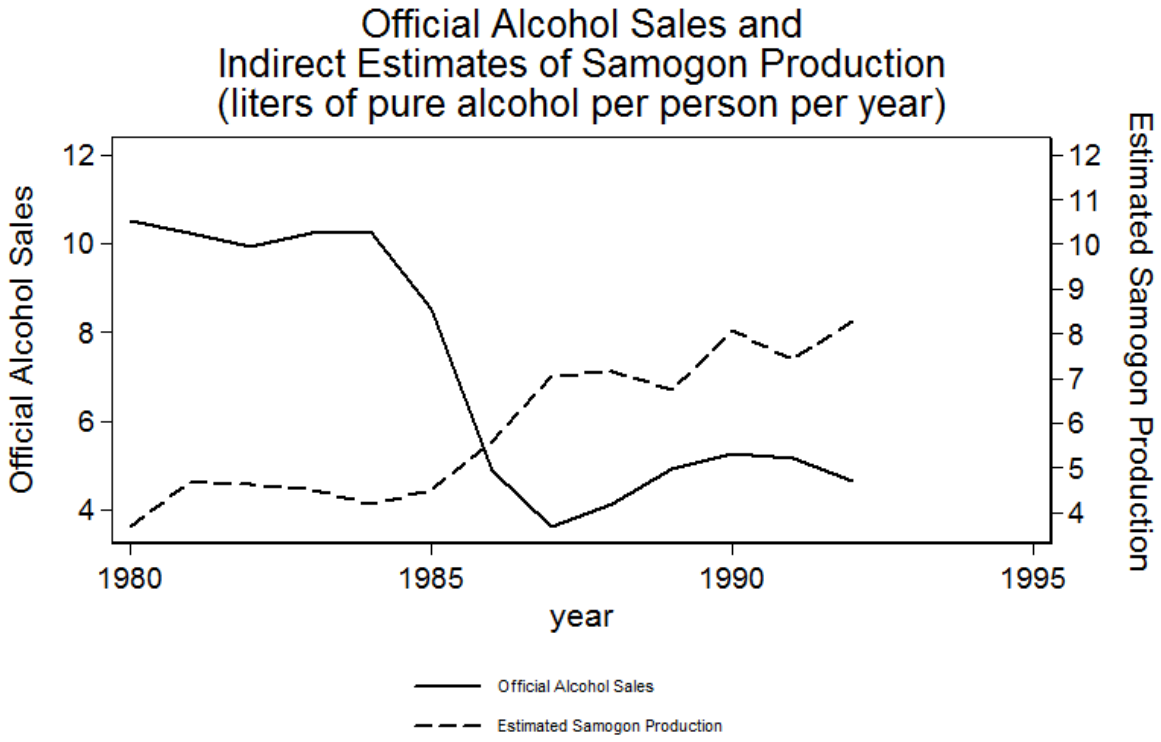
Appendix Figures 3-5 plot $\text{effect}_1(t)$ ... $\text{effect}_3(t)$. Appendix Figure 3 shows the mortality rate difference over time for *Scenario* 1 (which compares a counterfactual scenario in which everyone is a heavy drinker against one in which everyone is an abstainer). In the Framingham study cohort, the move from heavy drinking to abstinence would have lowered mortality rate for a seventeen-year period. But mortality rates would have risen during the following seventeen years. This happens because a move to abstinence would preserve alive some part of the population. This part of the population is presumably at a higher risk of mortality than other parts because a move to abstinence makes a difference in whether this part stays alive. In later years, as the population ages and mortality rates necessarily rise, this part of the population begins to die at higher rates. This compositional effect is analogous to what we term "catch-up" mortality in Russia after the end of the Gorbachev Anti-Alcohol Campaign.

Appendix Figure 4 shows the mortality rate difference over time for *Scenario* 2 (which compares mortality rates in a counterfactual scenario in which there is a five-year period during which heavy drinkers become light drinkers and moderate and light drinkers abstain against observed mortality). This "campaign" changes heavy drinkers into light drinkers and moderate and light drinkers into abstainers, and all individuals then revert to their pre-campaign drinking path. Given the results from *Scenario* 1, it is unsurprising to see an initial reduction in mortality during the campaign followed by an increase leading to excess mortality beginning three years after the campaign's end.

Appendix Figure 5 shows the mortality rate difference over time for *Scenario* 3 (which compares mortality rates in a counterfactual scenario in which the "campaign" from Scenario 2 is followed by two years of excessive drinking, and then a return to the pre-campaign drinking path, against observed mortality). The results are qualitatively similar to the previous graph – a decline in mortality during the "campaign" followed by an increase leading to excess mortality (larger in magnitude and longer lasting than in Scenario 2) about two years after the end of the campaign.

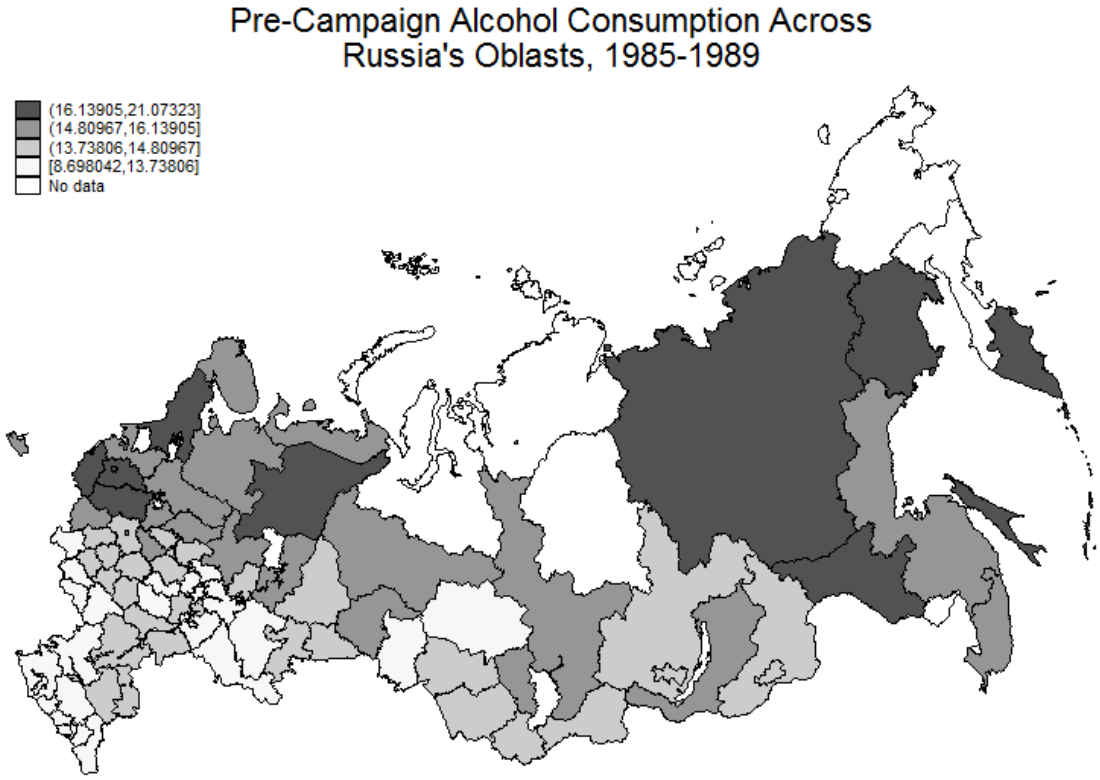
The magnitudes, patterns, and composition of alcohol consumption in the United States and Russia differ markedly. Our simulations using Framingham Heart Study data are nevertheless informative about mortality patterns in Russia assuming alcohol consumption and mortality have an approximately linear (or even convex) relationship. More generally, our primary objective is simply to establish general temporal relationships between alcohol consumption and mortality consistent with those observed in Russia during the latter 1980s and early 1990s.

Appendix Figure 1



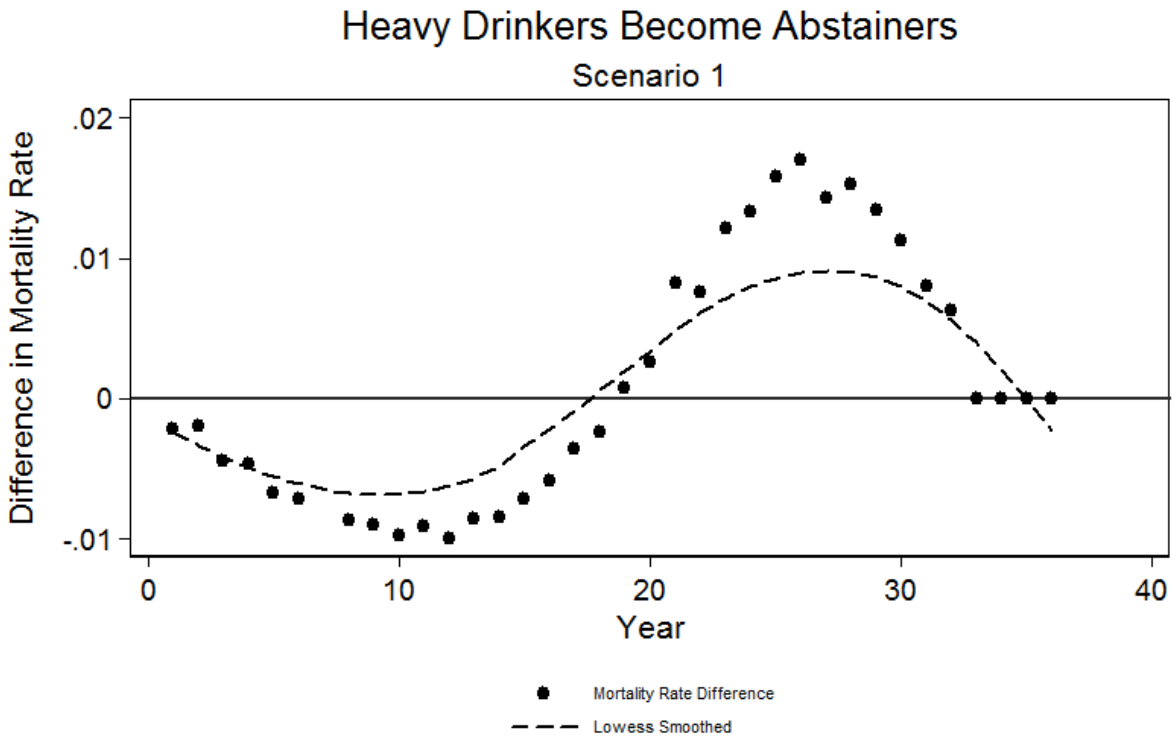
Data on official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of illegal alcohol production by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Appendix Figure 2

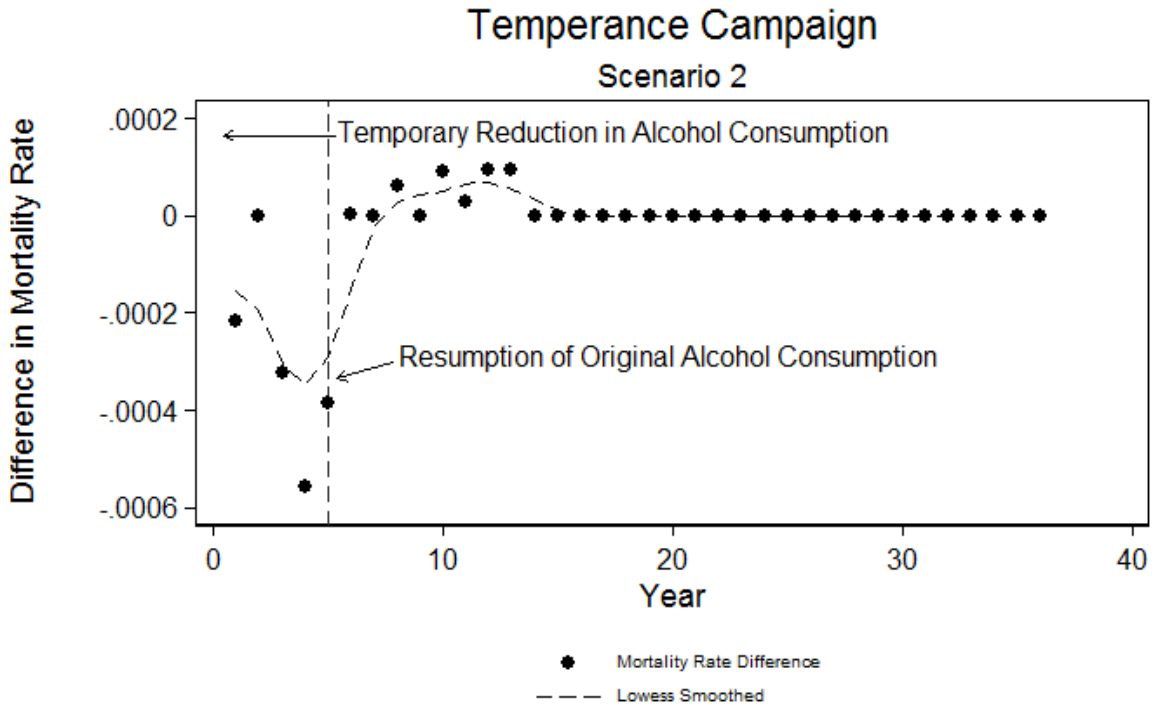


Estimates of total alcohol consumption from data on official alcohol sales and estimates of illegal alcohol production. Data on official alcohol sales are available in annual statistical yearbooks compiled by Goskomstat and Rosstat. Illegal alcohol production estimated by extending the work of Nemtsov (2000) (see Appendices 1 and 2 for details).

Appendix Figure 3

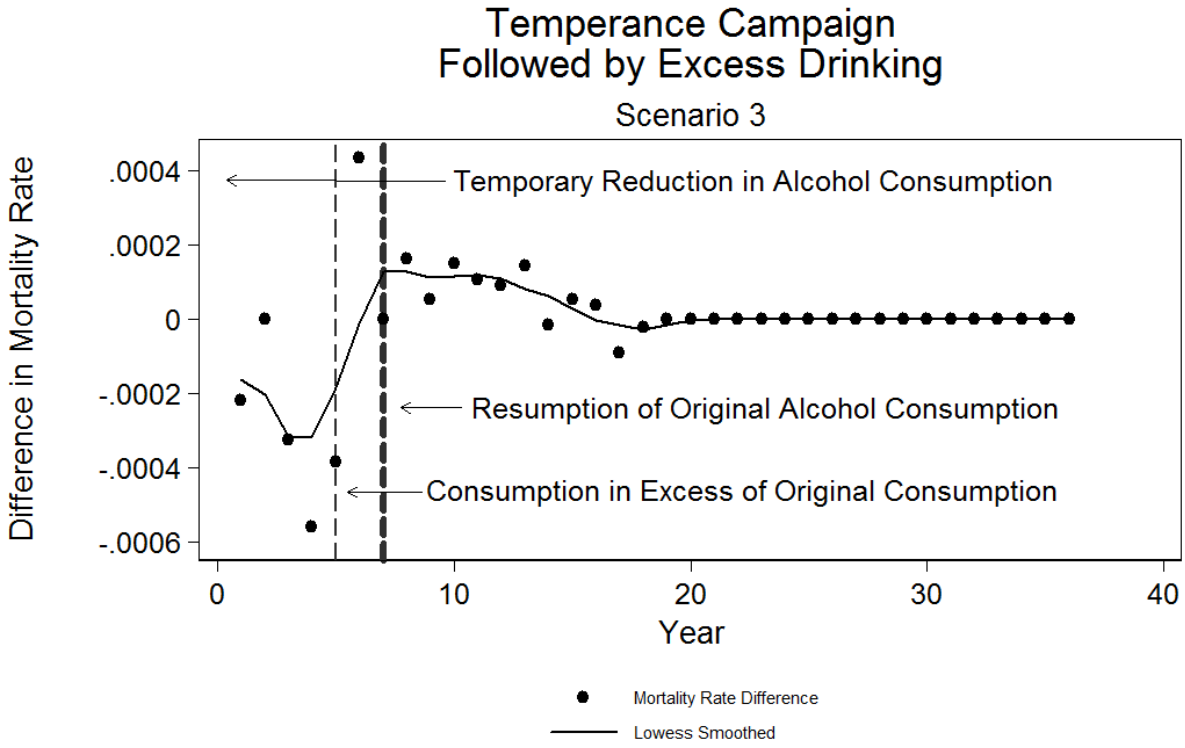


Appendix Figure 4



Note: t=1 is the first year of the 'campaign' and t=5 is the last year of the 'campaign'

Appendix Figure 5



Appendix Table 1
Pre-Campaign Alcohol Consumption and Mortality With and Without Oblasts With Lower Quality Data

Alcohol Measure:	**Total Alcohol Consumption**						**Official Alcohol Sales**					
Dependent Variable:	**Crude Death Rate**						**Crude Death Rate**					
Campaign Year Interactions												
Pre-Campaign Alcohol Consumption × 1985	-0.199***	-0.144***	-0.226**	-0.064	-0.277***	-0.113***	-0.193***	-0.138***	-0.219**	-0.064	-0.265***	-0.108***
	(0.058)	(0.033)	(0.086)	(0.044)	(0.060)	(0.025)	(0.056)	(0.032)	(0.084)	(0.043)	(0.058)	(0.026)
Pre-Campaign Alcohol Consumption × 1986	-0.234***	-0.196***	-0.225***	-0.123**	-0.264***	-0.091**	-0.227***	-0.184***	-0.219***	-0.121**	-0.255***	-0.085**
	(0.057)	(0.065)	(0.057)	(0.061)	(0.058)	(0.038)	(0.056)	(0.062)	(0.055)	(0.059)	(0.056)	(0.037)
Pre-Campaign Alcohol Consumption × 1988	-0.306***	-0.241***	-0.322***	-0.150**	-0.340***	-0.131***	-0.293***	-0.225***	-0.315***	-0.149**	-0.325***	-0.121***
	(0.052)	(0.069)	(0.086)	(0.063)	(0.056)	(0.046)	(0.051)	(0.065)	(0.084)	(0.061)	(0.054)	(0.044)
Pre-Campaign Alcohol Consumption × 1989	-0.278***	-0.211**	-0.292***	-0.119	-0.308***	-0.082	-0.265***	-0.194**	-0.282***	-0.117	-0.293***	-0.072
	(0.054)	(0.085)	(0.090)	(0.078)	(0.058)	(0.056)	(0.053)	(0.080)	(0.088)	(0.075)	(0.055)	(0.053)
Crisis Year Interactions												
Pre-Campaign Alcohol Consumption × 1990	-0.213***	-0.144*	-0.234**	-0.060	-0.266***	-0.021	-0.204***	-0.133*	-0.226**	-0.061	-0.252***	-0.014
	(0.055)	(0.080)	(0.093)	(0.083)	(0.054)	(0.059)	(0.053)	(0.076)	(0.091)	(0.080)	(0.052)	(0.057)
Pre-Campaign Alcohol Consumption × 1991	-0.167**	-0.093	-0.174**	-0.027	-0.268***	-0.006	-0.156**	-0.078	-0.163**	-0.025	-0.248***	0.006
	(0.072)	(0.072)	(0.083)	(0.080)	(0.071)	(0.060)	(0.071)	(0.069)	(0.081)	(0.078)	(0.069)	(0.060)
Pre-Campaign Alcohol Consumption × 1992	-0.034	0.047	-0.040	0.116	-0.126**	0.152*	-0.032	0.052	-0.039	0.109	-0.118**	0.151*
	(0.065)	(0.084)	(0.075)	(0.103)	(0.059)	(0.083)	(0.064)	(0.079)	(0.073)	(0.098)	(0.057)	(0.079)
Pre-Campaign Alcohol Consumption × 1993	0.131	0.221**	0.123	0.299***	-0.001	0.292***	0.125	0.218**	0.115	0.281***	-0.000	0.285***
	(0.099)	(0.093)	(0.110)	(0.106)	(0.087)	(0.094)	(0.095)	(0.087)	(0.106)	(0.100)	(0.083)	(0.090)
Pre-Campaign Alcohol Consumption × 1994	0.243*	0.340***	0.237*	0.425***	0.070	0.379***	0.227*	0.328***	0.220*	0.397***	0.061	0.362***
	(0.123)	(0.085)	(0.136)	(0.093)	(0.107)	(0.082)	(0.118)	(0.079)	(0.131)	(0.087)	(0.102)	(0.078)
Pre-Campaign Alcohol Consumption × 1995	0.324***	0.407***	0.306**	0.496***	0.192	0.517***	0.306***	0.394***	0.287**	0.466***	0.180	0.497***
	(0.118)	(0.107)	(0.124)	(0.100)	(0.137)	(0.088)	(0.113)	(0.100)	(0.119)	(0.097)	(0.131)	(0.084)
Pre-Campaign Alcohol Consumption × 1996	0.159*	0.245**	0.141	0.332***	0.032	0.373***	0.145*	0.236**	0.126	0.307***	0.022	0.355***
	(0.087)	(0.103)	(0.093)	(0.117)	(0.075)	(0.085)	(0.084)	(0.096)	(0.091)	(0.112)	(0.072)	(0.081)
Pre-Campaign Alcohol Consumption × 1997	0.028	0.116	0.010	0.203*	-0.127*	0.231***	0.018	0.113	-0.000	0.181	-0.132*	0.217***
	(0.095)	(0.105)	(0.100)	(0.116)	(0.074)	(0.083)	(0.092)	(0.098)	(0.097)	(0.112)	(0.071)	(0.080)
Pre-Campaign Alcohol Consumption × 1998	0.028	0.119	0.010	0.204	-0.113	0.261***	0.019	0.117	0.001	0.183	-0.117	0.248***
	(0.090)	(0.113)	(0.097)	(0.130)	(0.075)	(0.090)	(0.087)	(0.105)	(0.095)	(0.125)	(0.072)	(0.086)
Pre-Campaign Alcohol Consumption × 1999	0.129	0.222*	0.118	0.310**	-0.093	0.297***	0.112	0.211*	0.096	0.278**	-0.111	0.270***
	(0.137)	(0.121)	(0.145)	(0.127)	(0.092)	(0.100)	(0.133)	(0.113)	(0.140)	(0.122)	(0.087)	(0.095)
Pre-Campaign Alcohol Consumption × 2000	0.156	0.252*	0.148	0.344**	-0.103	0.303***	0.138	0.241*	0.125	0.311**	-0.120	0.277***
	(0.155)	(0.131)	(0.162)	(0.134)	(0.095)	(0.109)	(0.151)	(0.123)	(0.156)	(0.128)	(0.090)	(0.104)
Additional Controls												
Per capita number of doctors			-0.006	0.006					-0.006	0.005		
			(0.013)	(0.010)					(0.013)	(0.009)		
Per capita number of hospital beds			0.014	-0.042					0.012	-0.043		
			(0.073)	(0.036)					(0.074)	(0.036)		
Oblasts with Lower-Quality Data	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
Additional Controls	No	No	Yes	Yes	No	No	No	No	Yes	Yes	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast-Specific Time Trends	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	1,371		1,293	1,293	1,237	1,237	1,371	1,371	1,293	1,293	1,237	1,237
R^2	0.947		0.952	0.977	0.952	0.976	0.947	0.974	0.951	0.977	0.952	0.976

Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption by extending the work of Nemtsov (2000) for estimating illegal alcohol production (see Appendices 1 and 2 for details). Data sources for additional control variables available in Appendix 1. Table cells report OLS estimates obtained from equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Crude death rates are per 1,000 population. All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, 1988, and 1989-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

Appendix Table 2
Pre-Campaign Alcohol Consumption and Cause-Specific Mortality

Alcohol Measure:	Total Alcohol Consumption							
Dependent Variable:	**Alcohol Poisoning Death Rate (Total)**	**Alcohol Poisoning Death Rate (Male)**	**Alcohol Poisoning Death Rate (Female)**	**Circulatory Disease Death Rate**	**Accident or Violent Death Rate**	**Respiratory Disease Death Rate**	**Digestive Disease Death Rate**	**Cancer Death Rate**
Pre-Campaign Alcohol Consumption × 1988	-4.907***	-7.067***	-2.747***	-3.312	-9.521***	-1.686	-0.952	-0.475
	(0.870)	(1.124)	(0.669)	(5.512)	(1.533)	(1.656)	(0.611)	(1.146)
Pre-Campaign Alcohol Consumption × 1989	-4.295***	-6.078***	-2.511***					
	(1.000)	(1.380)	(0.697)					
Crisis Year Interactions								
Pre-Campaign Alcohol Consumption × 1990	-3.913***	-5.450***	-2.376***	-4.638	-6.791***	0.791	-0.0816	-0.357
	(0.830)	(1.112)	(0.641)	(3.447)	(1.315)	(1.511)	(0.512)	(0.760)
Pre-Campaign Alcohol Consumption × 1991	-3.603***	-5.168***	-2.039***	-4.532	-6.053***	1.326	-0.389	-0.102
	(1.174)	(1.704)	(0.713)	(3.331)	(1.560)	(1.682)	(0.561)	(1.012)
Pre-Campaign Alcohol Consumption × 1992	-1.839**	-2.349*	-1.328**	1.951	-0.213	1.797	-0.101	0.162
	(0.917)	(1.271)	(0.628)	(3.139)	(1.808)	(1.681)	(0.705)	(1.272)
Pre-Campaign Alcohol Consumption × 1993	2.501***	5.143***	-0.140	11.46**	9.308***	3.217**	1.275*	0.926
	(0.873)	(1.309)	(0.838)	(5.494)	(2.602)	(1.394)	(0.699)	(1.405)
Pre-Campaign Alcohol Consumption × 1994	2.472	4.624*	0.321	17.03**	11.28***	4.759***	1.340**	1.653
	(1.581)	(2.382)	(0.979)	(7.108)	(3.074)	(1.423)	(0.614)	(1.392)
Pre-Campaign Alcohol Consumption × 1995	0.0440	0.714	-0.626	19.70***	15.03**	4.948***	1.231**	1.841
	(1.117)	(1.472)	(0.826)	(6.007)	(6.624)	(1.321)	(0.609)	(1.782)
Pre-Campaign Alcohol Consumption × 1996	-2.028	-2.699	-1.356	15.12**	4.196**	4.236***	1.534**	1.792
	(1.244)	(1.670)	(0.850)	(5.909)	(1.598)	(1.122)	(0.606)	(1.658)
Pre-Campaign Alcohol Consumption × 1997	-2.988**	-4.166***	-1.809**	8.759	1.745	3.126***	0.831	1.233
	(1.160)	(1.522)	(0.825)	(6.231)	(1.630)	(1.159)	(0.579)	(1.477)
Pre-Campaign Alcohol Consumption × 1998	-3.174**	-4.378**	-1.969**	9.894	0.283	3.177**	0.889	1.569
	(1.271)	(1.695)	(0.900)	(6.250)	(1.802)	(1.243)	(0.647)	(1.595)
Pre-Campaign Alcohol Consumption × 1999	-3.098**	-4.370**	-1.827*	15.11*	1.485	3.846***	1.765**	2.510
	(1.430)	(1.968)	(0.938)	(8.685)	(2.516)	(1.190)	(0.735)	(1.905)
Pre-Campaign Alcohol Consumption × 2000	-1.464	-1.826	-1.102	14.17	3.775	4.576***	1.446*	2.597
	(1.542)	(2.142)	(0.976)	(9.506)	(3.719)	(1.315)	(0.853)	(1.937)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Oblast-Specific Time Trends	No	No	No	No	No	No	No	No
N	1,062	1,062	1,062	1,016	1,016	1,016	1,016	1,016
R^2	0.795	0.802	0.750	0.951	0.901	0.816	0.728	0.961

Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption by extending the work of Nemtsov (2000) for estimating illegal alcohol production (see Appendices 1 and 2 for details). Table cells report OLS estimates obtained from equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Crude death rates are per 1,000 population. Cause-specific death rates are per 100,000 population. All oblast-year samples are restricted to years prior to 2000 (1978, 1988-2000 for alcohol poisoining; 1978, 1988, 1990-2000 for other causes of death) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

Appendix Table 3
Implied Changes in Crude Death Rate: High and Low Drinking Oblasts

		Pre-Campaign Median Consumption				Implied Change in Mortality		
Year	Estimate of β	Median	Standard-Deviation	1 Standard Deviation Below Median	1 Standard Deviation Above Median	1 Standard Deviation Below Median	Median	1 Standard Deviation Above Median
1985	-0.14	14.38	2.00	12.38	16.38	-1.78	-2.07	-2.36
1986	-0.20	14.38	1.96	12.42	16.34	-2.43	-2.82	-3.20
1988	-0.24	14.38	1.93	12.45	16.31	-3.00	-3.47	-3.93
1989	-0.21	14.38	1.93	12.45	16.31	-2.63	-3.03	-3.44
1990	-0.14	14.38	2.00	12.38	16.38	-1.78	-2.07	-2.36
1991	-0.09	14.38	1.94	12.44	16.32	-1.15	-1.33	-1.51
1992	0.05	14.38	1.91	12.47	16.29	0.59	0.68	0.77
1993	0.22	14.38	1.80	12.58	16.18	2.78	3.18	3.58
1994	0.34	14.38	1.80	12.58	16.18	4.28	4.89	5.50
1995	0.41	14.38	1.90	12.48	16.28	5.08	5.85	6.63
1996	0.25	14.38	1.90	12.48	16.28	3.06	3.52	3.99
1997	0.12	14.38	1.90	12.48	16.28	1.45	1.67	1.89
1998	0.12	14.38	1.90	12.48	16.28	1.49	1.71	1.94
1999	0.22	14.38	1.99	12.39	16.37	2.75	3.19	3.63
2000	0.25	14.38	1.99	12.39	16.37	3.12	3.62	4.13

Data on death rates and official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992), Treml and Alexeev (1993), Vassin and Costello (1997), Vallin et al. (2005) as well as from Vladimir Shkolnikov and colleagues at the Max Planck Institute for Demographic Research; estimates of total alcohol consumption by extending the work of Nemtsov (2000) for estimating illegal alcohol production (see Appendices 1 and 2 for details). Estimated coefficients for each year obtained through OLS estimation of equation (1) for interactions between oblast-level mean pre-campaign alcohol consumption and campaign year dummy variables. All specifications include oblast and year fixed effects. Alcohol consumption is measured in liters per capita. Changes in mortality reflect the number deaths averted (or excess deaths) per 1,000 population. All oblast-year samples are restricted to years prior to 2000 (1970, 1978, 1980, 1985, 1986, and 1988-2000) and exclude Tuva, Dagastan Republic, Ingushitya Republic, Chechen Republic, Kabardino-Balkarskaya Republic, Karachaevo-Cherkesskaya Republic, North Osetiya-Alaniya Republic, Krasnodarskiy Krai, and Stavropolski Krai. Standard errors clustered at the oblast level shown in parentheses. *p<0.10, **p<0.05, and ***p<0.01.

Appendix Table 4
Comparison of Total Alcohol Consumption Estimates
(Including *Samogon*) with Nemtsov (2000)

	1984 Total Alcohol Consumption		1990 Total Alcohol Consumption	
Year:	Estimate	Nemtsov (2000)	Estimate	Nemtsov (2000)
Region:				
North and Northwest	16.0	15.6	12.5	12.3
Central	14.3	14.6	12.4	12.2
Northern Caucasus	13.0	12.7	11.0	10.7
Urals and Volga country	14.0	13.9	11.8	11.4
Western Siberia	14.8	14.8	13.4	12.8
Russian Far East	17.2	16.7	13.5	13.3

Data on official alcohol sales were obtained from annual statistical yearbooks compiled by Goskomstat and Rosstat through East View Information Services and the Hoover Institution's "Russian/Soviet/Commonwealth of Independent States Collection" print archives with supplementation from New World Demographics (1992); estimates of total alcohol consumption by extending the work of Nemtsov (2000) for estimating illegal alcohol production (see Appendices 1 and 2 for details).

Appendix Table 5:
An Aging Framingham Population

Variable	Wave 1		Wave 7		Wave 17		Wave 23	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Alcohol Consumption								
none	.	.	0.41	0.49	0.45	0.5	0.61	0.49
light	.	.	0.14	0.35	0.14	0.34	0.14	0.35
moderate	.	.	0.28	0.45	0.28	0.45	0.19	0.39
heavy	.	.	0.17	0.38	0.13	0.34	0.07	0.25
Education								
8th grade or less	0.29	0.45	0.28	0.45	0.24	0.42	0.2	0.4
some high school	0.14	0.35	0.14	0.35	0.14	0.34	0.13	0.33
high school graduate	0.29	0.46	0.3	0.46	0.32	0.47	0.35	0.48
some college	0.08	0.27	0.08	0.27	0.09	0.28	0.09	0.28
college graduate	0.08	0.27	0.08	0.27	0.09	0.28	0.08	0.27
post-graduate	0.12	0.33	0.13	0.33	0.14	0.35	0.16	0.37
male	0.45	0.5	0.44	0.5	0.38	0.49	0.34	0.47
age	44.52	8.57	56.14	8.46	73.59	7.46	82.5	5.71
N	5,209		4,851		3,113		1,602	

Data from the Framingham Heart Study (sample construction described in Appendix 3)

Appendix Table 6
Mortality Hazard Ratios- Cox Proportional Hazards Model

Variable	Hazard Ratio	Robust Standard Error	95% Confidence Interval
Alcohol Consumption			
none	Reference Group		
light	0.92	-0.049	[0.83 - 1.03]
moderate	0.96	-0.039	[0.88 - 1.04]
heavy	1.11	-0.059	[1.00 - 1.23]
Education			
8th grade or less	Reference Group		
some high school	1	-0.054	[0.90 - 1.11]
high school graduate	0.97	-0.044	[0.89 - 1.06]
some college	0.82	-0.054	[0.72 - 0.94]
college graduate	0.88	-0.06	[0.78 - 1.01]
post-graduate	0.84	-0.047	[0.75 - 0.93]
male	1.52	-0.054	[1.42 - 1.63]
age	1.08	-0.003	[1.08 - 1.09]

Log L = -23796.28

Data from the Framingham Heart Study (sample construction described in Appendix 3). Hazard estimates obtained by estimating (1) in Appendix 3

Appendix Table 7
Two Counterfactual Paths

	$j = 3$	$j = 4$
$t \leq 5$	• If $none_{it} = 1$, $light_{it} = 1$ or $moderate_{it} = 1$, set $\widehat{none}_{it}^{3} = 1$ • If $heavy_{it} = 1$, set $\widehat{light}_{it}^{3} = 1$	• If $none_{it} = 1$, $light_{it} = 1$ or $moderate_{it} = 1$, set $\widehat{none}_{it}^{4} = 1$ • If $heavy_{it} = 1$, set $\widehat{light}_{it}^{4} = 1$
$5 < t \leq 7$	• Set $\widehat{alc}_{it}^{3} = alc_{it}$	• If $none_{it} = 1$, set $\widehat{light}_{it}^{4} = 1$ • If $light_{it} = 1$, set $\widehat{moderate}_{it}^{4} = 1$ • If $moderate_{it} = 1$, set $\widehat{heavy}_{it}^{4} = 1$
$t > 7$	• Set $\widehat{alc}_{it}^{3} = alc_{it}$	• Set $\widehat{alc}_{it}^{4} = alc_{it}$