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Deindustrialization and the postsocialist mortality crisis

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Deindustrialization and the postsocialist mortality crisis

Abstract

An unprecedented mortality crisis struck Eastern Europe during the transition from socialism to capitalism. Working-class men without a college degree suffered the most. Some argue that economic dislocation caused stress and despair, leading to adverse health behavior and ill health (dislocation-despair approach). Others suggest that hazardous drinking inherited as part of a dysfunctional working-class culture and populist alcohol policy were the key determinants (supply-culture approach). We enter this debate by performing the first quantitative analysis of the association between economic dislocation in the form of industrial employment decline and mortality in postsocialist Eastern Europe. We rely on a novel multilevel dataset, fitting survival and panel models covering 52 towns and 42,800 people in 1989-1995 in Hungary and 514 medium-sized towns in the European part of Russia. The results show that deindustrialization was significantly associated with male mortality in both countries directly and indirectly mediated by adverse health behavior as a dysfunctional coping strategy. Both countries experienced severe deindustrialization, but social and economic policies seem to have offset Hungary's more immense industrial employment loss. The policy implication is that social and economic policies addressing the underlying causes of stress and despair can improve health.

Keywords: deindustrialization, inequality, stress, despair, mortality

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Introduction

An unprecedented mortality crisis hit the former socialist countries in the early 1990s, representing one of the most significant demographic shocks after the Second World War outside war or famine. The number of excess deaths could have been around 7.3 million in Eastern Europe in 1991-1999 (Stuckler 2009:7). Male life expectancy in Russia declined by seven years between 1988 and 1995. At the Western edge of postsocialist Eastern Europe, Hungary also suffered a significant though less dramatic mortality crisis, with male life expectancy declining by 1.5 years between 1988 and 1994. Life chances have been improving from the second half of the 1990s throughout postsocialist Eastern Europe, but most countries are still plagued by high health inequalities and higher death rates than predicted by their economic development level. In addition to emigration and low fertility, these prevalent health problems are among the primary reasons why the ten countries with the fastest shrinking population are all located in Eastern Europe (United Nations 2017).

Working-class men without a college degree were hit particularly hard, leading to a widening mortality gap by education from the 1980s to the 1990s (Doniec et al. 2018). Middle-aged men saw their death rates increase by around 50% from 1980 to 1994 in Hungary and Russia (Human Mortality Database 2020). In both countries, deaths considered sensitive to social disintegration and psychosocial stress increased the most, such as deaths due to mental disorders, homicides, alcohol (digestive system diseases, injury, and poisoning), and ischemic heart disease. There is a consensus in the literature that alcohol and heart-related deaths contributed the most to the excess deaths (Shkolnikov et al. 1998; Zaridze et al. 2009).

However, disagreement persists concerning the upstream factors — what Marmot called the “causes of causes” of ill health (Marmot 2018) — and the underlying causal mechanisms that link these upstream factors to downstream determinants of health. The majority of public health scholars — proponents of the dislocation-despair approach — agrees that stress and despair caused by rapid social change and economic dislocation were crucial upstream factors behind these excess deaths (Azarova et al. 2017; Cornia 2000; Gavrilova et al. 2000; Scheiring et al. 2018; Stuckler et al. 2009; Walberg et al. 1998). However, others — proponents of the supply-culture approach — question the role of economic dislocation in the postsocialist mortality crisis and argue that the excess mortality was driven primarily by adverse lifestyles inherited from the socialist past that was aggravated by increased alcohol supply during the early transition years (Bhattacharya et al. 2013; Carlson and Hoffmann 2011; Cockerham et al. 2002; Cockerham 2007; Treisman 2010). This debate has clear policy implications: if economic dislocation is a significant correlate of ill health, then social and economic policies addressing the underlying causes of stress and despair could be at least as essential to improving healthy life expectancy as controlling the supply of harmful substances or improving health education (Venkataramani et al. 2021).

Understanding the role of deindustrialization in the postsocialist mortality crisis is crucial for several reasons. First, there is a renewed sociological interest in assessing the social costs of the postsocialist transformation (Bandelj and Mahutga 2010; Fodor and Horn 2015). Many connect the rise of populists in Eastern Europe to “the failure of liberalism to deliver” (cf. Krastev 2016), even in countries considered more successful, such as Viktor Orban’s Hungary (Scheiring 2020b). This democratic malaise underscores the importance of understanding the lived experience of postsocialist change. Second, many emerging economies are experiencing premature deindustrialization, even if at a less dramatic pace (Rodrik 2016). Industrial employment decline could be a crucial correlate of individual health in these emerging economies also. Third, global competition, technological change (Alderson 1999), and the need to mitigate climate change (Jorgenson and Clark 2012) will continue to put pressure on industrial employment. Evidence suggests that industrial employment decline might be an essential correlate of workers’ increasing death rates in the U.S. (Case and Deaton 2020; Monnat 2019; Seltzer 2020; Venkataramani et al. 2020).

In this article, we present the first quantitative analysis of the role of deindustrialization in the postsocialist mortality crisis. We ask whether deindustrialization was directly and independently associated with the excess deaths and increased hazardous drinking as the dislocation-despair approach suggests. Alternatively, whether alcohol availability (price) and inherited industrial working-class culture (higher initial share of industrial employment) explain the mortality crisis, as suggested by the supply-culture approach. We also control for other potential confounding mechanisms, such as migration and pre-existing health differentials. We use an innovative multilevel dataset and a retrospective cohort study originating in the Privatization and Mortality project, the biggest data-gathering effort addressing the postsocialist mortality crisis to date (Irdam et al. 2016). Covering 52 towns and 42,800 subjects, we analyze how deindustrialization was associated with all-cause mortality in Hungary in 1989-1995 using multilevel survival models, corroborating the results with town-level fixed-effects models. Using data on 514 medium-sized towns in the European part of Russia, covering the 49 most populous regions, 20.9 million inhabitants, i.e., 14.1% of the country's population, we also explore the association of industrial employment decline and health in Russia through fixed-effects panel regressions.

The results show that deindustrialization was directly associated with male mortality in both countries. We did not find evidence supporting the role of dysfunctional working-class legacy in Hungary. While we could not rule out its role in Russia, it does not overwrite the health effect of deindustrialization. Russia's results also show that deindustrialization was also associated with increased drinking independently of alcohol availability and that alcohol price is a weak candidate for explaining increased hazardous drinking. These results present robust support for the dislocation-despair argument and suggest that the postsocialist mortality crisis cannot be adequately explained by relying only on the supply-culture approach. We hypothesize that these correlations could signal that deindustrialization is a critical source of stress and despair through individual-level (income loss, job loss, precarity) and the contextual-level processes (loss of community, increased inequality, loss of company-related services). These mechanisms explain deindustrialization's direct adverse health effect and its effect on hazardous health behavior as a dysfunctional coping strategy.

The article is structured as follows. First, we present an overview of the trends in mortality and deindustrialization in the two countries. Next, we present the competing approaches in more detail, using the extant literature to foreground deindustrialization as a neglected but potentially critical upstream factor, and deriving testable hypotheses. We continue by describing the methodology and the sources of the data. In the subsequent section, we present the results, first focusing on Hungary, then on Russia. Then we continue by discussing our results in the light of the literature, analyzing the similarities and differences between the two countries. Finally, we conclude by briefly highlighting the study's implications for other emerging economies experiencing deindustrialization and its relevance for understanding and responding to the deaths of despair epidemic among workers in the North American Rust Belt.

Patterns of postsocialist mortality

Rapid modernization under the early years of state socialism brought improvements in infectious and poverty-related diseases (Cockerham 1997). In the middle of the 1960s, Eastern Europeans' life expectancy was very close to that of Western Europeans. However, beginning in the second half of the 1960s, life expectancy stagnated and even declined in some years (Bobak and Marmot 1996). Cardiovascular deaths, hazardous drinking, and smoking played a central role in this health crisis (Carlson and Hoffmann 2011). In the second half of the 1980s, death rates began to decline, leading to significant life expectancy gains in most countries in Eastern Europe. However, the transition to capitalism from state socialism was accompanied by a renewed increase in mortality.

The intensity of this postsocialist mortality crisis varied across the region; former members of the Soviet Union suffered the most, while life expectancy in Poland and Czechia started to increase in the early 1990s. Though some see the postsocialist mortality crisis as a continuation of past demographic trends (Bhattacharya et al. 2013; Carlson and Hoffmann 2011), research showed that the wave of excess deaths in the 1990s goes well beyond what could be explained by secular trend effects (Brainerd and Cutler 2005; Cornia and Paniccià 2000; Shkolnikov et al. 1998). High and growing health inequalities still plague most Eastern European countries. Mortality differences by education exploded as the death rates of low-educed middle-aged people have continued to grow until the early 2000s (Doniec et al. 2018; Mackenbach et al. 2018). Regional mortality differences also grew rapidly throughout the 1990s and 2000s, even as overall life expectancy increased (Bíró et al. 2021).

Figure 1 summarizes the postsocialist mortality crisis in Hungary and Russia, compared to the average of Visegrad countries that are frequently considered the most successful Eastern European transition countries (Czech Republic, Poland, Slovakia, excluding Hungary).[1]

[Figure 1]

[1] Deindustrialization in Poland, Slovakia and Czech Republic was much less severe compared to Hungary. In the Czech Republic, overall employment declined by 1%, in Poland by 12% between 1989 and 1995. Employment declined in Hungary by 22% in the same period. For more details, including the number of bankruptcies and other comparative measures of economic disintegration see Scheiring (2020b:133-86).

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In 1988, the average life expectancy of men at birth in Russia was 2.83 years below the Visegrad average. The same gap was 1.81 years in the case of Hungary in 1988. While Poland, Czechia, and Slovakia saw a steady improvement during the early 1990s, Russia's male life expectancy gap grew to 10.88 years and Hungary's to 3.57 years.[2] In the 1990s, blue-collar male workers with less than secondary education had 111% higher odds of dying than those with a college degree in Hungary, representing a 17% increase compared to the 1980s, and 50% higher odds of dying in Russia, representing a 14% increase compared to the 1980s (Doniec et al. 2018). However, this does not mean the mortality crisis is driven by direct material deprivation. Wealthier, more urbanized, and industrialized regions in Russia suffered a more severe wave of excess deaths than more impoverished regions (Walberg et al. 1998). Research has also ruled out that poverty-related malnutrition played a significant role (Cornia and Paniccià 2000).[3]

The trends in different cause-specific age-standardized death rates point towards the importance of despair and stress driven by economic dislocation, summarized in Tables A1 and A2 in the appendix based on WHO (2020). Diseases sensitive to the quality of health care, industrial pollution, and the extent of extreme poverty — such as infant deaths and infectious diseases — declined (Brainerd and Cutler 2005).[4] Health indicators related to pollution also improved from the end of the 1980s following industrial decline (Nell and Stewart 1994:16-17). In contrast, deaths sensitive to psychosocial stress grew rapidly. Deaths due to mental disorders increased from 14.6 to 25.6 per 100,000 in Hungary and from 2.6 to 16.7 in Russia in 1989-1995. Although their contribution to overall mortality is less than 2%, and the changing recognition of mental disorders could have played a role, the magnitude of the increase suggests it is real and reveals underlying social tensions.

The same is true for the digestive system diseases — including alcohol-related liver diseases and cirrhosis — that increased from 113.9 to 160.9 in Hungary and from 44.1 to 68.8 per 100,000 in Russia in 1989-1995, again by far exceeding the 1986-1988 decline. Hazardous drinking has been a significant problem in both countries, but binge drinking — drinking very

[2] Men were hit harder than women in this period; therefore, we focus on male life expectancy and death rates.

[3] Infectious epidemics disproportionately burden the poor in developing countries but this was not the case in the postsocialist region with developed welfare states.

[4] Cancer deaths also increased – but their tendency is gradual, distributed evenly across the 1980s and 1990s, whereas the other types of deaths increased most in the early 1990s.

large quantities in a short time — was particularly severe in Russia (McKee 1999). This explains why Russia also saw a steep rise in other alcohol-related deaths, such as injury and poisoning, that almost doubled in the same period. Homicides also increased by 3.2 times in Russia and by 1.4 times in Hungary between 1989-1995. Ischemic heart diseases also increased substantially, by close 10% in Hungary and 75% in Russia in the same period.[5] Brainerd and Cutler (2005) estimated that cardiovascular diseases accounted for 42%, while hazardous drinking and its consequences for 32% of the total increase in male mortality in Russia in 1989-1994. In short, during the transition to capitalism, Russians and Hungarians experienced mental disorders and died of drinking and myocardial infarction in increasing numbers.

The age distribution of the postsocialist wave of excess deaths also underlines the potential role of economic dislocation, despair, and distress; see Figure A1 in the appendix using data from the Human Mortality Database (2020). In both countries, middle-aged men were hit more than younger or older generations, reflecting an increase in age groups that are generally considered less vulnerable to epidemics and healthcare quality (Stuckler 2009:15).[6] In Hungary, the 35-39 age group's death rate was more than 50% higher in 93-94 than in 1980. In Russia, those aged 40-54 were hit the hardest, with 50-60% higher death rates than in 1980. The increase in the middle age group is approximately similar in the two countries. However,, in Russia, other age categories also saw elevated death rates, though less pronounced. Thus, Russia's mortality crisis affected all age groups, but middle-aged working-class men were hit hardest in both countries.

Dislocation-despair contra alcohol supply and culture

The clues analyzed in the previous section point to the potential role of distress, despair, and economic dislocation. Labor market disintegration could have been a crucial source of stress and despair. Existing research showed that unemployment and labor market turnover were associated with the wave of excess deaths (Perlman and Bobak 2009; Walberg et al. 1998). Even

[5] Though concerning Western Europe some studies reported that drinking moderate amounts of alcohol is heart-protective, this was not the case in the East. Bing drinking has been established as an important factor behind heart attacks in Russia (Britton and McKee 2000).

[6] To reduce the bias resulting from the fluctuation in the second half of the 1980s, we compare death rates to 1980.

those who kept their job but experienced higher workload and decreased control at work were at higher risk of dying (Lundberg et al. 2007; Pikhart et al. 2001). Qualitative research also revealed that deindustrialization in former socialist industrial towns led to social disintegration, status loss, the loss of communities, and a cascade of infrastructural, social, and health problems, depression, prolonged stress, and despair both in Russia and Hungary (Hegedűs 2010; Kideckel 2008; Parsons 2014; Scheiring 2020a). Growing depressive symptoms, despair, and distress were also robustly correlated with Hungarians' increased mortality (Kopp et al. 2000; Kopp et al. 2007).

A related stream of studies argued that mass privatization was a critical economic policy factor behind the transition economic crisis (Hamm et al. 2012), also driving the life expectancy decline (Stuckler et al. 2009) and alcohol-related deaths in Russia (King et al. 2009). A later study using a quasi-experimental design with individuals nested in a matched set of towns with and without mass privatization in Russia confirmed the association (Azarova et al. 2017). Simultaneously, prolonged state ownership appears to have been health-protective compared to privatization in Hungary, according to another multilevel study that also filtered out the confounding through pre-existing health differentials (Scheiring et al. 2018). The research on the economic sources of Eastern European's despair and stress has not paid sufficient attention to deindustrialization.

However, proponents of the competing supply-culture approach argued that "there is a lack of evidence documenting a relationship between stress and health outcomes" (Cockerham 2007:459). Some posited that the correlation between privatization and mortality was spurious (Earle and Gehlbach 2010; Gerry 2012). Others suggested that mortality was driven primarily by adverse lifestyles inherited from the socialist past, with the "state socialist mortality syndrome" rooted in socialist over-industrialization and the attendant dysfunctional working-class culture harboring adverse health behavior (Carlson and Hoffmann 2011; Cockerham et al. 2002; Cockerham 2007). As Carlson and Hoffmann (2011:375) argued, "state socialist development policies emphasizing industrial employment at the expense of the service sector created conditions that appeared consistently in the right times and places to explain subsequent rises in working-age male mortality." Carlson and Hoffman use excessive industrialization as a core explanatory variable for elevated death rates under socialism and extend its effect until 1995, thus covering the postsocialist mortality crisis.[7]

Cockerham et al. (2002:43) also argued that adverse health lifestyles are "the primary determinant of the decline in life expectancy in former socialist nations," adding that "these lifestyle practices are especially characteristic of middle-aged, working-class men," the archetypical "Homo Sovieticus." This working-class culture was "reinforced by a lack of public health campaigns advocating healthy individual practices" (Cockerham 2007:461). Cockerham (2007) also added the lack of an educated upper middle class as an explanatory component.

Others added that the increased availability of alcohol aggravated the socialist legacy of dysfunctional working-class culture. Treisman (2010:312) presented evidence suggesting that "populist politics" in the early 1990s led to a reversal from the Gorbachev anti-alcohol campaign and a relative decline in the price of vodka, and concluded that the rise in hazardous drinking "resulted from a sharp drop in the price of vodka relative to those of other goods, including beer" (314). According to Bhattacharya et al., when the 1985-1988 Gorbachev Anti-Alcohol Campaign ended, the relative price of vodka dropped, and the prevalence of hazardous drinking grew again, which is said to explain the mortality crisis in the early 1990s. Bhattacharya et al. (2013:232) conclude that "Russia's transition to capitalism … was not as lethal as commonly suggested."[8]

Because the industrial working-class was the backbone of socialist ideology and culture (Burawoy and Lukács 1992; Pittaway 2014; Stenning 2005), it is reasonable to assume that a dysfunctional working-class legacy would correlate with industrial employment. Based on the supply-culture approach, we can hypothesize that higher initial industrial employment levels — preceding the onset of deindustrialization — and alcohol price decline would be the crucial determinants of elevated mortality in the 1990s.

[7] In fact, their regression models cover five-year intervals from 1960 to 2005.

[8] Other behavioral factors such as smoking or unhealthy diets either did not worsen or improved in most countries during the transition, thus cannot explain the parallel increase in mortality (Cornia and Paniccià 2000). A global comparative study found that obesity, lack of exercise, and smoking explained the lowest fraction of the variation in heart disease in Eastern European countries compared to any other region in the world (Yusuf et al. 2004).

Deindustrialization, stress, and despair

In this study, we extend the extant literature on dislocation and despair by focusing on deindustrialization. Tables 1 and 2 summarize the key indicators of the socio-economic transformation in Hungary and Russia, respectively. Multiple problems plagued the socialist industry as a result of the forced rapid development of the heavy industry. Socialist companies provided many non-essential functions that decreased their productivity, and they were also characterized by overemployment.[9] It is clear that the socialist industry needed to be reformed, but the modalities of this industrial transformation are subject to debate (Amsden et al. 1994). Both countries experienced severe employment decline during the transition to capitalism, but industrial employment decline exceeded the economy-wide average employment decline. While overall employment declined by 24% in Hungary between 1987 and 1995, manufacturing employment fell by 53% in the same period, the years of the country's most pronounced liberalization measures. This extreme deindustrialization in Hungary was very severe and rapid by international standards. The most deindustrialized American metropolises, such as Philadelphia, Cleveland, and Chicago, lost around 30% of their manufacturing labor force between 1972 and 1987 (Wallace et al. 1999:115). Representing one of the worst cases globally, deindustrialization in West Central Scotland reached 62% *over 30 years* between 1971 and 2005 (Walsh et al. 2009). In comparison, within less than a decade, every second person employed in manufacturing in Hungary lost their job.

[Table 1]

In contrast to Hungary, Russia (see Table 2) experienced a steep decline in output and wages. However, compared to Hungary, industrial employment decline in Russia was dispersed overall a more extended period. Total employment declined by 16% between 1987-1999, while industrial employment dropped by 46% in the same period. Compared to Hungary, economic adjustment to the new competitive capitalist environment took place more through the income

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[9] However, survey research with managers in socialist enterprises showed that economists tended to overestimate the problem of labor hoarding, an issue that managers did not find to be the most pressing problem that companies were facing in the early years of the transition (Clarke 1998).

channel in Russia, leading to a more pronounced decline in aggregate income and wages, while income in Hungary fell less and adjustment took place more through the employment channel (Boeri and Terrell 2002; Gimpelson and Kapelyushnikov 2011). Russian policymakers allowed companies to keep their workers while reducing and delaying their salaries. While physical production in industry fell by 35% between 1990 and 1993, employment in the industry fell by only 9% in the same period (Clarke 1998:19). Thus, industrial employment decline might only capture a limited dimension of deindustrialization in Russia.

[Table 2]

The Socialist industry played a crucial role in workers' lives, providing stable, life-time jobs and a comparatively high salary. Industrial workers enjoyed high social status as the backbone of state socialist societies (Burawoy and Lukács 1992; Pittaway 2014; Stenning 2005). Industrial employment was, therefore, a crucial source of identity, especially for working-class men. Companies also provided a host of free services, including health, care, housing, holiday homes, sports- and cultural facilities. Russian enterprises spent around 3–5 percent of GDP on social provision, while East European firms spent about half this amount, which is still very significant (Cook 2007:39-40). Industrial employment also contributed to social integration, vibrant work- and neighborhood communities (Kideckel 2002; Scheiring 2020a). Thus, although industrial working class culture also harbored adverse lifestyles such as drinking (Carlson and Hoffmann 2011; Cockerham et al. 2002), industrial plants also contributed to health and well-being in many ways.

These company functions were lost with mass plant closures, with potentially significant health implications. The extant research has established that deindustrialization is correlated with protracted unemployment (Kollmeyer and Pichler 2013), income poverty (Brady and Wallace 2001), increased labor market precarity (Iversen and Cusack 2011; Kalleberg 2009), the erosion of communities and communal identities (Bluestone and Harrison 1982; Lamont 2000), higher income inequality (Moller et al. 2009). These consequences of deindustrialization — such as unemployment (Walberg et al. 1998), labor market precarity and job strain (Perlman and Bobak 2009; Pikhart et al. 2001), income loss, growing inequality (Marmot and Bobak 2005), the erosion of communities (Kennedy et al. 1998; Kideckel 2008; Parsons 2014) — have all been associated with increased mortality in postsocialist countries.

Based on these considerations, we hypothesize that deindustrialization was an important upstream economic correlate behind the excess postsocialist deaths associated with health through individual (declining income, job loss, increasing job precarity) and contextual pathways (loss of communities, growing income inequality, loss of company-based services). We also hypothesize that deindustrialization was also associated with increased drinking as a dysfunctional stress-coping mechanism.

Data and methods

Data

The analysis is based on two datasets, one on Hungary, the other on Russia.

For Hungary, we assembled a novel multilevel dataset comprising town and individual-level data as part of the Privatization and Mortality (PrivMort) project (Irdam et al. 2016). When analyzing Hungary, we focus on 1989-1995. Both deindustrialization and the wave of excess deaths were concentrated in this period. There was no deindustrialization in Hungary after 1995, and it was less significant before 1988, as shown in Table 1.[10]

The first pillar of the multilevel dataset (level 1) comprises a broad scope of individual-level data collected in a *retrospective cohort study* between January 2014 and December 2015. In each selected town, interviewers visited randomly selected addresses for face-to-face interviews. The primary screening criteria were having parents, siblings, or male partners (for females) living in the same settlement between 1980 and 2010. Interviewers only interviewed one respondent from each household regardless of the size of the family. The average response rate was 85%. Following the method of retrospective cohort studies (Mann 2003), respondents provided information on their relatives' (parents, siblings, and spouses) vital status, year of birth

[10] The Hungarian Central Statistical Office stopped reporting annual town-level industrial employment from 1998. Since we are interested in the effect of deindustrialization in the mortality crisis, we did not extend the analysis to cover 1996-1998 when the economy and life expectancy was already growing. The 1989-1995 period encompasses seven years, which is more than economists argued would be required for the benefits of industrial restructuring to outweigh the potential problems. Lipton and Sachs (1992:214) argued that that market adjustments would increase wealth and would lead to improvements in health, with "enormous scope for increases in living standards *in a few years*, particularly as resources are shifted out of the military-industrial complex into other sectors."

and death (if applicable), education, smoking, and drinking. As respondents themselves could not have died, we only included respondents' relatives in the analysis who lived in the surveyed towns during the 1980s and the 1990s (N=43,532). We further reduced the sample by excluding cases with missing information on gender. In total, 42,800 people met these criteria and were included in this analysis: 24,377 men and 18,423 women. The subjects' mean age in 1989 was 51 years (SD=16.8). The average number of subjects per town was 881.[11] Table A3 in the appendix presents a summary of the individual data for Hungary.

The second pillar of the multilevel dataset (level 2) covers town-level data in annual time series format collected from the Hungarian Central Statistical Office. Towns were randomly selected between 5,000 and 100,000 inhabitants with industrial employment (as a share of total employment) in 1989 exceeding 30% (N=110) — the same towns where individual surveys were later conducted. Because our primary concern is the health impact of the collapse of industrial plants, we concentrated on towns with significant industrial capacities. Predominantly agricultural small towns and villages experienced a different type of economic shock. Hungary only has nine cities with more than 100,000 inhabitants, and these were excluded from the sample. In terms of economic geography, Hungary is a highly polarized country, dominated by Budapest and its agglomeration, which could introduce bias; thus, the Budapest agglomeration was excluded from the sample. Thus, a set of 52 towns was generated covering the entire geographical area of Hungary. The sample represents the types of mid-sized towns where most Hungarians live and can be used to assess the impact of deindustrialization in non-metropolitan urban areas.[12] Table A4 in the Appendix presents a summary of town-level data for Hungary.

The second dataset covers towns in the European part of Russia, also collected under the PrivMort project's auspices (Irdam et al. 2016). Because Russia experienced two economic crises during the transition in the 1990s and more prolonged deindustrialization running at least until 1998, we analyze the 1991-1999 period. The dataset includes 514 medium-sized towns in the European part of Russia where the population exceeded 3,000 but was smaller than 200,000

[11] For further details on the methodology and reliability of the individual surveys see Irdam et al. (2016).

[12] A more heterogeneous sample would have required collecting data on significantly more towns (subsequent quantitative and qualitative fieldwork in these towns collected individual-level data), which would have been beyond the practical limits of this already big research project.

in 1989. These towns are located in the 49 most populous regions of Russia. The total population in the sampled towns was 20.9 million, i.e., 14.1% of Russia's total population. We can justifiably extrapolate this finding to the non-metropolitan areas in European Russia.

We assessed the quality of the data regarding mortality in the sample of 514 towns by calculating the mean crude death rates across the towns in each year between 1991 and 1999 and compared them with the respective national-level statistics, as shown in Figure A2. While being lower in levels, the line for the sample of towns generally tracks the national-level trend. Therefore, we conclude that the selected set of towns represents a robust sample that can be used to assess the association between deindustrialization and mortality in European Russia.

Table A5 in the Appendix presents a summary of town-level data for Russia. For Russia, gender-specific town-level death rates were not available, so we use overall death rates covering both men and women. In addition to the income, age structure, number of inhabitants, net migration, health care provision, and housing conditions, we were also able to collect data on regional-level average alcohol consumption and the regional-level average alcohol price. We use these two variables to check the robustness of the deindustrialization variable against the alcohol policy hypothesis, which suggested that the excess deaths in the 1990s resulted from the relative drop of alcohol price and increased alcohol consumption after the Gorbachev anti-alcohol campaign ended. The information on industrial employment, death rates, income, age structure, number of inhabitants, migration, health care provision, housing conditions, alcohol price, and total alcohol consumption was obtained from the Federal Statistics Service (Rosstat) yearbooks.

Analysis

For Hungary, we fitted two types of models. First, we examined the relationship between deindustrialization and mortality using multilevel discrete-time survival analysis, with individuals (level 1) nested in towns (level 2), with random intercepts and random slopes. In these multilevel models, we conceptualize deindustrialization as a contextual variable associated with health through individual and contextual pathways described in the previous section. To capture the non-contemporaneous effect of deindustrialization, in the multilevel models, we measure deindustrialization as a change in industrial employment (manufacturing, mining, and construction) from 1989 to 1995 expressed as a percentage of each town's total population. The mean value of deindustrialization in the 52 towns was 41%, the median value was 40%. We grouped towns in two categories: those where deindustrialization equals or exceeds 50% (n=16) and those where it was below 50% (n=36) — approximately corresponding to the national average value of deindustrialization in this period. Our variable definition is in line with the methodological approach used by Mitchell et al. (2000) and Rind et al. (2014), who used similar contextual categorical variables to measure the association between deindustrialization and health. The dependent variable in the multilevel models reflects the odds of dying in the 52 towns during the 1989-1995 period, also controlling for year fixed effects.[13]

We used a series of indicators derived from the social determinants of health literature to control for town-level heterogeneity. Firstly, using data on outmigration, we can filter out the effect of healthier people leaving the towns, thus biasing the primary association. Secondly, the towns' population size could also influence mortality and could influence the effect of modernization and industrialization; therefore, we include a variable in our models measuring the mean number of inhabitants. The age composition of towns could also influence the primary association. To filter out this effect, we use towns' dependency ratio as a proxy of age structure. Controlling for the prediction that "wealthier is healthier," we include a variable measuring town-level per capita income. Finally, we also control for the number of unemployed people, while the number of general practitioners is used as a proxy for the towns' health infrastructure. At the individual level, we control for subjects' age, gender, education, smoking, alcohol consumption, and marital status. All models include additional controls for year fixed-effects and the subjects' relationship status to the respondent to filter out potential bias due to survey design where siblings, spouses, parents, and children provided information on the subjects.

Complementing the multilevel models, we also fitted fixed-effects models using only town-level administrative time series data. In these panel models, the independent variable is continuous, measuring the annual deindustrialization compared to 1989, using the same data as for constructing the contextual deindustrialization variable in the multilevel models. The dependent variable is the annual town-level all-age male death rate (number of male deaths / 100.000), with mortality data available for the 1990-1995 period. The panel covers the same 52

[13] The limitations of the individual survey data also necessitated the use of an indicator variable as the main independent variable. Because of recall bias (see limitations section), we could not generate an outcome variable for fine-tuned year-on-year mortality risk analysis.

towns with 310 observations (town-years) and is strongly balanced, with only two missing data points in total. We used a similar set of control variables as in the case of the multilevel models. The fixed effects models filter out towns' time-invariant characteristics by design, and we also included year dummies to filter out unobserved time-variants.

We also implemented several robustness checks. First, we assessed the robustness of the multilevel association between deindustrialization and mortality against pre-existing health differentials. We also checked against another source of potential selection bias from outmigration following the analysis period and before the individual surveys were conducted. Finally, we assessed the robustness of the association against initial levels of industrial employment.

For Russia, sufficient individual-level data were not available; therefore, we used regional- and town-level data, fitting fixed effects models.[14] In these panel models for Russia, the dependent variable measures town-level annual all-age deaths per 100,000 population (both genders). The primary independent variable of interest is the cumulative change in the town-level industrial employment-to-population ratio (1991 as baseline). In our sample of 514 middle-sized towns, the median decrease in industrial employment between 1991-1999 was 39%. Only 13 percent of towns did not suffer a decrease in industrial employment.

We ran models on the period from 1991 to 1999. To understand the town-level drivers of mortality during the transition, we start by fitting regressions with town fixed effects to our panel data set. Model 1 is a bivariate regression with town fixed effects and year dummies, while models 2, 3, and 4 include additional explanatory variables, following the model construction logic used for Hungary, including some additional control variables that were not available for Hungary. We control for wage in 1991 rubles, number of inhabitants in 1000s, dependency ratio, net of out and in-migration per person, per person floor space, number of physicians per 100,000 and hospital beds per 10,000.

To assess whether the association between industrial employment and mortality was robust to alcohol policy, we carried out additional analyses. First, we checked the correlation of industrial employment decline and alcohol price with pure alcohol consumption, using the same

[14] In Russia, individual surveys were conducted in a matched set of towns with and without mass privatization, which is not suitable to analyze the effect of deindustrialization.

dataset and same control variables as above. Next, we compared the coefficient size of deindustrialization and alcohol consumption on mortality, again using the same control variables. Finally, we assessed the robustness of the deindustrialization-mortality association against the initial level of industrial employment.

All statistical analyses were carried out using STATA 16.0 (StataCorp, Texas, USA). Despite the multiple robustness checks against potential selection bias and unobserved heterogeneity, causality is beyond the scope of our work. We hope that the correlational patterns identified will inspire future work designed to assess causal connections.

Results for Hungary

First, we present the results of the multilevel models. We specified our models based on our theoretical concerns and methodological considerations. Our baseline model 1 only includes the primary independent variable. Model 2 includes individual-level control variables. We found no multicollinearity among the individual-level variables (measured by the variance inflation factor, VIF). Model 3 includes town-level control variables. First, we regressed each town-level control variable on mortality separately, but none came close to significance, except for unemployment. Outmigration, the number of GPs, and town-level income were not significantly associated with the dependent variable, so we removed them from the analysis to avoid multicollinearity. For theoretical reasons, we decided to keep the controls for population size, age structure, and initial mortality rates, in addition to the unemployment variable that approached significance.[15] Finally, model 4 includes each control variable simultaneously. We present the results as odds ratios (OR). We considered associations statistically significant if the p-value obtained was below 0.05. The results for women were not significant, so we only report them in the appendix (Table A6).

Table 3 presents the results of multilevel survival models. Men living in towns experiencing severe deindustrialization (a collapse in industrial employment equal to or greater than 50%) have higher odds of dying than men living in towns where deindustrialization was moderate (below 50%) in every model. After adjusting for potential town- and individual-level

[15] Table A7 of the appendix presents the association between these additional town-level control variables and mortality.

factors including towns' population, unemployment rate, age structure, and initial death rates, as well as individuals' characteristics such as education, smoking, alcohol consumption, marital status, and age as shown in model 4, Table 3, we still observed a strong association. Among men, living in towns that experienced severe deindustrialization was associated with 21.4% higher odds of dying than living in moderately deindustrialized towns in the 1989-1995 period.[16] Model 4, Table 3 also shows that working-class men with primary education (the reference category) had a 32%-higher odds ratio of dying than those with a college degree, net of the effect of other factors.

[Table 3]

The only town-level control variable approaching significance is registered unemployment (thus the number of people receiving unemployment benefit), but this association is only significant when controlling for individual characteristics too (Table 3, model 4). When controlling for every town- and individual-level factor, we found that a 1% increase in registered unemployment was associated with 1.7% lower odds of dying among men in 1989-1995.

Figure 2 shows the predicted marginal probability of dying in the 1989-1995 period by the extent of deindustrialization (using industrial employment change deciles) adjusted according to the specification of model 4. The association between deindustrialization and mortality is non-linear. People living in the most severely deindustrialized decile of towns had a 40%-higher predicted probability of dying than people living in the least deindustrialized decile.

[Figure 2]

To filter out potential selection bias, we asked whether town-level death rates in 1989 predict individual mortality between 1989 and 1995 but found no significant association in any of the models in Table 3. Our second strategy provides an even more reliable guarantee against the potential that pre-existing mortality differentials may have played a role. We constructed a separate dataset using subjects who lived in the 52 towns during the 1980s before

[16] We also analyzed the sensitivity of the results to variable specification. We estimated the association between mortality and deindustrialization, operationalizing the latter as a categorical variable with three and four categories. These results confirmed the main findings. Results available on request.

deindustrialization began in 1989. We used this dataset to investigate the town and individual-level determinants of subjects' death between 1985 and 1988, including the level of deindustrialization that happened after 1989. As Table 4 shows, we found no significant pre-existing mortality differences among men living in the towns that later underwent different industrial transformations.

[Table 4]

To check the explanatory power of dysfunctional working-class culture, we also analyzed the role of initial employment in industry in multiple ways. First, the correlation between initial industrial employment and deindustrialization is very low (r=-0.04). Thus the initial level of industrial employment does not seem to explain subsequent deindustrialization. Next, we analyzed whether industrial employment at the beginning of deindustrialization (in 1989) influences mortality differentials in multilevel regression models. Industrial employment in 1989 was measured as a continuous variable (min.: 0.1, max.: 0.63), expressing the share of the total population employed in industry in percentages. As we report in Model 5, Table A7 of the appendix, higher industrial employment in 1989 is associated with *lower* odds of dying between 1989 and 1995 — contrary to the dysfunctional working-class culture hypothesis. A hypothetical 100%-share of industrial employment in 1989 correlates with 55.4% lower odds of dying than no industrial employment; i.e., a 1% increase in initial industrialization decreases the odds of dying later by around 5%.

We also examined the role of initial industrial employment by stratifying the sample by low and high initial industrial employment levels. As Table A8 reports, the association between deindustrialization and health is more powerful with lower initial industrial employment levels, again contradicting the dysfunctional working-class culture hypothesis. Severe deindustrialization in towns with lower initial industrial employment levels correlates with 30.6% higher odds of mortality for men than towns with moderate deindustrialization (Model 3).

A further potential source of selection bias might stem from migration. Towns that disproportionately lose younger or healthier people would exhibit a higher mortality rate than towns that lose fewer people or less healthy people. Conversely, if people affected by unemployment migrate to other towns, then migration might introduce a downward bias on mortality. Therefore, we controlled for outmigration covering the 1989-1995 period and outmigration and in-migration covering the post-treatment period leading up to the interview date (1996-2015). As shown in models 3-5, Table A7 in the appendix, none of the migration-related variables are significant, and their inclusion does not influence the effect of deindustrialization.

We also checked the association between town-level male mortality and deindustrialization measured annually as a continuous variable, using administratively collected town-level data covering the same 52 settlements. Figure 3 shows the association between towns' mean male mortality and industrial employment change in the 1989-1995 period. The correlation appears to be strong, with male mortality increasing as industrial employment collapses, then mortality starting to decline as deindustrialization stops. Some towns only experienced a short period of deindustrialization, while in others, it lasted until 1995-1996 in Hungary. In the long run, more deindustrialized towns might also experience lower improvements in health, contributing to health inequality across towns that have been growing throughout the 1990s and 2000s (Bíró et al. 2021). However, investigating this long-term association is beyond the scope of the present study.

[Figure 3]

Table 5 shows the results of the town-level fixed-effects panel regressions. Confirming the multilevel models, deindustrialization is robustly associated with male mortality in every model. Model 4 – controlling for towns' size, age structure, unemployment, per capita income, outmigration, and the number of GPs – shows a highly significant association ($p=0.002$); an additional 1% deindustrialization correlates with 1.74 additional male deaths per 100,000 inhabitants. Except for age structure (dependency ratio), none of the control variables were significant.

[Table 5]

Results for Russia

As described above, we investigated the correlation between deindustrialization and health in Russia using town-level fixed effects modeling covering mid-sized towns in European Russia. First, we investigate the association visually. As Figure 4 shows, the correlation between industrial employment decline and mortality is less robust in Russia than in Hungary. As we discuss later, industrial employment decline might miss essential aspects of deindustrialization in Russia, and the outcome variable, including both male and female death rates, might also dilute the effect. In addition to deindustrialization, other upstream processes might be more important in Russia.

[Figure 4]

The regression results are presented in Table 6. We start by fitting regressions with year dummies and town fixed effects to our panel data set to understand the town-level covariates of mortality. Given declining trends in industrial employment, we can interpret the coefficients in model 1 as follows: a decrease in industrial employment of 1 percent was associated with 0.407 ($p<0.01$) more deaths per year per 100,000 population in the 1991-1999 period. This estimate is not attenuated by accounting for per capita income and square meters of accommodation in model 2. The association holds after controlling for the number of inhabitants, dependency ratio, per capita net migration in model 3. We observe no reduction in magnitude or significance when we control for the number of physicians per 100,000 and hospital beds per 10,000 population in model 4 and fully adjusted model 5. The association between deindustrialization and mortality remains positive and highly significant in all four models, varying between $b=0.404$ ($p<0.001$) in model 2 and $b=0.526$ ($p<0.001$) in model 3.

[Table 6]

The proponents of the supply-culture approach questioned the idea that stress caused by economic dislocation would be an essential determinant of hazardous drinking, arguing for the centrality of dysfunctional culture and alcohol supply. To assess this hypothesis, we analyzed the association between deindustrialization and drinking. Table 7 shows the coefficients and standard errors for a percentage share of industrial employment on alcohol consumption for this period in models 1 and 3 (full model). The models also show the effect of alcohol price on its consumption in a bivariate model 2, and in a model with both industrial employment share, price of alcohol, and other covariates, namely wage in 1991 rubles, number of inhabitants in 1000s, and per-person floor space.

[Table 7]

The association between the drop in industrial employment and alcohol consumption remains significant in both specifications, indicating an increase of 0.013 liters per person per year with every one percent decrease in the industrial employment-per-population ratio. Thus, deindustrialization seems to be associated with increased alcohol consumption, filtering out the effect of alcohol price, thus suggesting the role of hazardous alcohol consumption as a dysfunctional stress-coping strategy. The correlation of price with alcohol consumption is minimal and not significant in bivariate model 2. However, in full model 3, the price of alcohol is positively correlated with consumption. Each ruble of increase in alcohol price correlates with 0.017 ($p<0.001$) liters more pure alcohol consumption in model 3. This finding is opposite to that predicted by Treisman's (2010) alcohol price hypothesis.

Finally, we compared the effect size of deindustrialization and alcohol consumption. Table 8 displays the coefficients for unstandardized and standardized values of deindustrialization and alcohol consumption adjusted for the same set of covariates as in Table 7. Both deindustrialization and alcohol consumption show a significant correlation with mortality. Every additional liter of alcohol consumption per capita increases the mortality rate by 10.67 deaths per 100,000 in model 2. This is a much larger effect than the effect of deindustrialization in model 1, which is 0.52 more deaths per each percent of deindustrialization. However, the results of models on standardized and centered values show that the size of the effect of one standard deviation change of deindustrialization alcohol is very similar to the size of the effect of alcohol consumption. One standard deviation of cumulative decrease in industrial employment is correlated with 24.7 extra deaths per 100,000 of the population, while one standard deviation increase in alcohol consumption is associated with 26 extra deaths per 100,000. However, we have to consider that alcohol consumption is measured at the regional level, but deindustrialization at the town level.

[Table 8]

As discussed earlier, a possible alternative explanation for the consistent and robust effect of industrial employment could be that those highly industrialized towns had higher death rates due to the lingering adverse health effect of socialist industrialization and the attendant health-damaging working-class culture. However, the increased level in crude death rates in initially highly industrialized towns was no higher than in initially less industrialized towns. As Figure A3 in the Appendix shows, the association between the change in death rate and initial industrial employment strength in the total population is entirely flat. The superimposed regression lines demonstrate that the initial level of industrialization does not seem to correlate with subsequent changes in death rates, defined as the increase in death rate in 1995 relative to the death rate in 1991 and increase in death rate in 1999 relative to the death rate in 1991.

Discussion

In this article, we contributed to the debate about the upstream socioeconomic causes of the postsocialist mortality crisis by examining the role of deindustrialization. It is beyond doubt that the socialist industry needed reform and exhibited multiple inefficiencies, including labor hoarding. The question we posed in this study was how the form of industrial restructuring that unfolded in Hungary and Russia correlated with ill health.

Underpinning the dislocation-despair approach, we showed that industrial employment decline was robustly associated with the mortality crisis in Hungary and Russia in the 1990s. We also showed that pre-transformation mortality differentials or subsequent migration patterns do not explain the negative health impact of deindustrialization. In addition, we showed that deindustrialization might have also been associated with the increase of the death rates through hazardous drinking. We found clear evidence for the importance of individual health behavior, but we do not find it fruitful to juxtapose health behavior and economic dislocation. Using standardized coefficients, the effect size of deindustrialization on mortality in Russia appears comparable to the effect size of alcohol consumption.

Simultaneously, our results suggest that the supply-culture approach might be insufficient to explain the mortality crisis. Past industrialization — a proxy of dysfunctional working-class legacies — was not associated with health negatively in Hungary and did not appear to influence the deindustrialization-health association in Russia. However, for Russia, we did not rule out the possibility that past industrialization played a role. Even if it did, and even though our measure of deindustrialization for Russia is not the most appropriate, industrial employment decline shows an independent correlation with ill health regardless of working-class legacies. Alcohol supply also does not appear to be a robust explanation. While price was not associated with alcohol consumption in a bivariate model, it was positively associated with it in the fully adjusted model, contradicting the "populist alcohol policy" hypothesis.

Our results on deindustrialization and alcohol in Russia are consistent with the extant literature on the determinants of drinking. Research using individual-level data from the Russian Longitudinal Monitoring Survey (RLMS) found that the increase in the price of vodka led to an increase in the consumption of home-made alcohol; as a result, the price of vodka had minimal effect on the total ethanol consumption in Russia (Andrienko and Nemtsov 2005; Goryakin et al. 2015). There was also a considerable divergence in the extent of excess deaths within former Soviet Union member states, which cannot be explained by the common alcohol policy across these states. Furthermore, mortality also increased in some countries outside the former Soviet Union where there was no Gorbachev-type anti-alcohol campaign at all, such as Hungary. These factors question the relevance of the alcohol supply effect. Research showed hazardous drinking was robustly associated with economic dislocation and stress as a coping mechanism to deal with life crises and a decline in social status (Gugushvili et al. 2018; Murphy et al. 2012; Saburova et al. 2011).

We found that deindustrialization was correlated only with men's health in the short run, echoing the existing literature on the health effect of privatization in Russia (Azarova et al. 2017). In the 1990s, unemployment grew faster among women than among men both in Russia and Hungary (Gerber and Mayorova 2006). However, the gendered expectations related to the male breadwinner model could have made men more vulnerable to labor market upheaval. Also, men were overrepresented in industrial jobs. Thus the decline of industrial employment had a concentrated effect on men (Gerber and Mayorova 2006). However, in the long run, men might benefit more from the new jobs emerging replacing old industrial ones. Women in towns with a higher share of privatization had higher odds of dying compared to women in towns with higher state ownership in the 1995-2004 period in Hungary (Scheiring et al. 2018).

Finally, it is worth pointing out that some of our models for Hungary showed that registered unemployment is negatively associated with mortality. This negative association could reflect the cushioning impact of unemployment benefits (Bambra and Eikemo 2009). The maximum duration of unemployment benefit in Hungary between 1989-1993 was 24 months, with the unemployed receiving 70% of their previous gross earnings during the first six months of unemployment (Vodopivec et al. 2005). Other aspects of Hungary's welfare state — unmeasured in this study — could be equally important. Hungarian policymakers attempted to pacify the unemployed by employing "strategic social policies," most notably promoting various forms of early retirement (Bohle and Greskovits 2012; Vanhuysse 2006). Finally, Hungary's privatization strategy was more gradual and orderly than Russia's rapid mass privatization and the attendant disintegration of bureaucratic capacities. These social and economic policy differences could have played an important role in offsetting deindustrialization's health effect in Hungary, even though Hungary experienced more significant industrial employment loss.

In contrast to Hungary, the Russian welfare state was less developed, and the bureaucratic capacity, in general, was negatively affected by mass privatization and the transition (Hamm et al. 2012; Irdam et al. 2015). The unemployment insurance system was practically non-existent compared to Hungary (Clarke 1998:50-52). Although on paper a redundant employee was entitled to the last monthly wage for the first three months paid by the employer, followed by 75% of the wage for the next three months, then 60% for four months and 45% for five months, this in practice meant a very low unemployment benefit. Lay-offs in Russia were the last resort; unpaid or partially paid leave was a common practice. Thus, the final monthly payment of those laid off was usually very low. Average unemployment benefit in 1993 was 12% of average pay, and 18% of average pay in 1994, and the average length of receipt of benefit was five months — figures that are in stark contrast to Hungary's unemployment benefit in the early 1990s. As a result, only 12% of the unemployed had received any help in Russia in 1992. The welfare state's weakness, the chaotic mass privatization program, the precarity of employment, the more severe income loss, and inflation could explain why Russia experienced a more severe wave of excess deaths than Hungary, even though deindustrialization was lower.

Our results are conservative calculations that likely underestimate the health effect of deindustrialization. First, we measured deindustrialization as industrial employment decline, which might not be the most appropriate measure to capture deindustrialization in Russia, where the collapse in production and value added went much beyond employment loss. Second, unlike in the Hungarian sample, gender-specific death rates were not available for Russia, so the panel regressions on Russia are based on overall death rates. This may have significantly diluted the effect of deindustrialization, as results for Hungary showed that deindustrialization did not significantly correlate with female mortality. Third, more nuanced mediation analysis could further reveal the indirect effects of deindustrialization mediated by social disintegration (loss of social capital), precarity, and inequality (by education, ethnicity, and regional), which all have been associated with higher mortality in postsocialist countries. Fourth, severely deindustrialized towns could be plagued by long-term unemployment, as sociologists have shown for Western countries (Kollmeyer and Pichler 2013). Deindustrial brownfield legacies could be important for health inequality, including growing ethnic health inequalities across towns (Harper 2012; Ladányi and Szelényi 2006). These persistent economic lock-in effects of deindustrialization could significantly contribute to long-term health inequalities across towns, even as the economic situation improves and average life expectancy increases (Bíró et al. 2021).

Some dimensions of the transition seem to be less relevant for the mortality crisis. We controlled for health service proxy variables both in the Hungarian and Russian analyses, and they were not significant and did not influence the primary association. The extant literature also shows that healthcare quality and coverage are not likely to have played a significant role (Brainerd and Cutler 2005; Cornia and Paniccià 2000). The political transformation is also a weak candidate for the primary explanatory variable: the quality of democracy in the early 1990s did not vary enough *within* countries to explain significant cross-town differences in excess deaths (Mackenbach et al. 2013).[17] Other economic policies — such as austerity or rapid import and capital account liberalization — could have also been associated with the mortality crisis, and they could have been an essential factor behind deindustrialization too (Alderson 1999; Amsden et al. 1994), as has been shown for the U.S. (Dean and Kimmel 2019). As discussed, rapid privatization also likely contributed to mortality and potentially to deindustrialization

[17] For example, the type and quality of the political institutional framework to emerge in Hungary and Poland was very similar. Yet, the mortality crisis in Hungary was significant, in Poland it was negligible. Socialist ideology or nostalgia is also a misleading clue: 80% of Hungarians supported the transition to capitalism in 1990, more than most neighboring countries that did not experience a comparable mortality crisis (Pew Research Centre 2009:5).

(Azarova et al. 2017; King et al. 2009; Stuckler et al. 2009). Though the implementation of these structural reform policies was more rapid than in many other countries, this economic policy mix is not unique to the postsocialist region; they are part and parcel of the Washington Consensus (Babb and Kentikelenis 2021). Our results fit into a growing stream of political-economy of health scholarship showing the adverse health effect of these neoliberal policies (Beckfield and Krieger 2009; Kentikelenis 2017; Navarro 2007; Schrecker and Bambra 2015).

Limitations

Our study has some limitations. The individual sample used for the multilevel models in Hungary is constructed from the close kin of those who were still living in the specific town in 2014-2015. This data collection procedure excludes those families that were in the town from 1989-1995 but no longer there when the interviews were conducted. However, by collecting data on interviewees' parents, spouses, and siblings, we significantly increased the chance of including those who migrated but had a relative remaining in the town. Second, this indirect demographic method has been validated and is recommended by the United Nations for use in censuses as a method yielding reliable and robust estimates (United Nations 1983). Previous studies conducted in Russia have already validated the method, showing that the resulting mortality estimates were similar to official data and were consistent with the literature (Bobak et al. 2002; Bobak et al. 2003). We also controlled for outmigration and in-migration in our models. Nevertheless, we have to take into account that migration might still bias the estimates.

Second, the retrospective cohort method might also be prone to recall bias. People might err a few years when recollecting when their relative died. We also found subjects' answers about the occupation and place of work of their relatives unreliable. Thus, we excluded these variables from the analysis. Therefore, our individual-level data cannot be used for fine-tuned year-on-year mortality risk analysis; thus, we could not generate a panel dataset using individual data. However, our town-level fixed-effects panel models, using administratively collected death rates from two separate countries, confirmed the multilevel models.

Third, the towns involved in the analysis might differ along unobservable characteristics in both countries. We tackled this limitation by controlling for pre-existing health differentials, which suggest that the towns did not differ in terms of health before the onset of deindustrialization—the fixed-effects models, by definition, filter out unobserved time-invariant heterogeneity. We also controlled for time-variant global factors by including year fixed effects both in multilevel models and in the panel regressions. We could also control for the most critical characteristics identified in the literature, such as health behavior, education, size of towns, age structure, or outmigration.

Fourth, our sample is restricted to medium-sized towns in both countries. Smaller towns and villages experienced a different shock related to the collapse of agriculture. Though we filtered out the role of the town's population size in every regression model, we do not claim that the results represent towns regardless of their size. Although we think it is valid to use our point estimates to calculate the nationwide health impact of industrial transformation, this estimate should be interpreted with caution due to the limited sample.

Observational data have limitations that need to be taken into account. All in all, we warn against interpreting the results as causal associations.

Conclusions

The insight that abrupt socioeconomic change might be associated with ill health goes back to the roots of social science. Durkheim (2002[1897]:207) famously concluded that "whenever serious re-adjustments take place in the social order, whether or not due to a sudden growth or an unexpected catastrophe, men are more inclined to self-destruction." Engels (2009[1845]:106) captured another way in which the early transition to capitalism led to mortality in England: "[W]hen society places hundreds of proletarians in such a position that they inevitably meet a too early and an unnatural death; when it deprives thousands of the necessaries of life, places them under conditions in which they cannot live, and yet permits these conditions to remain, its deed is murder."

Though the structure of the economy and the surrounding institutions have changed profoundly since then, and instead of poverty, it is economic dislocation and the attendant stress and despair that matter more for ill health, our results suggest that the transition to capitalism in Eastern Europe involved similar problems analyzed by Durkheim and Engels. We identified the economic dislocation caused by deindustrialization as a crucial correlate of the postsocialist mortality crisis, contributing to these ongoing sociological efforts to re-evaluate the transition to capitalism.

We believe that these insights are relevant for other countries beyond postsocialist Eastern Europe. Though waning, the "Washington Consensus" promoting privatization, liberalization, and deregulation is still high on International Financial Institutions' agendas. These policies have been implicated in the "premature deindustrialization" of emerging economies (Brady et al. 2011; Rodrik 2016), with potentially high health and well-being costs. Deindustrialization has also been identified as a crucial upstream determinant of the "deaths of despair" epidemic plaguing North America's working class (Case and Deaton 2020; Seltzer 2020; Venkataramani et al. 2020) and other parts of Western Europe (Mitchell et al. 2000; Walsh et al. 2009), especially when combined with a mix of neoliberal policies (Taulbut et al. 2013). Our results echo the findings of this scholarship on the deaths of despair about the negative health effect of economic dislocation, labor market disintegration, and the collapse of working-class communities.

Economic policies intended to "free up" markets and maximize growth, and health policies focusing only on healthy lifestyles are insufficient. Thus, in addition to standard welfare provisions, active labor market policies and community regeneration programs could be necessary (Venkataramani et al. 2021). Beyond social policy, there is also a renewed role for industrial policy (Rodrik 2004). Health policy and industrial policy are not anathemas to each other (Chorev 2019; Shadlen and Fonseca 2013). Government intervention to promote industrial development can make health policies more effective. Complex strategies, such as the green new deal, just transition, and regionally targeted industrial policies — relying on the strategic collaboration between the private sector, the national and local governments — can create sustainable jobs in rustbelt areas and contribute to the health of vulnerable populations.

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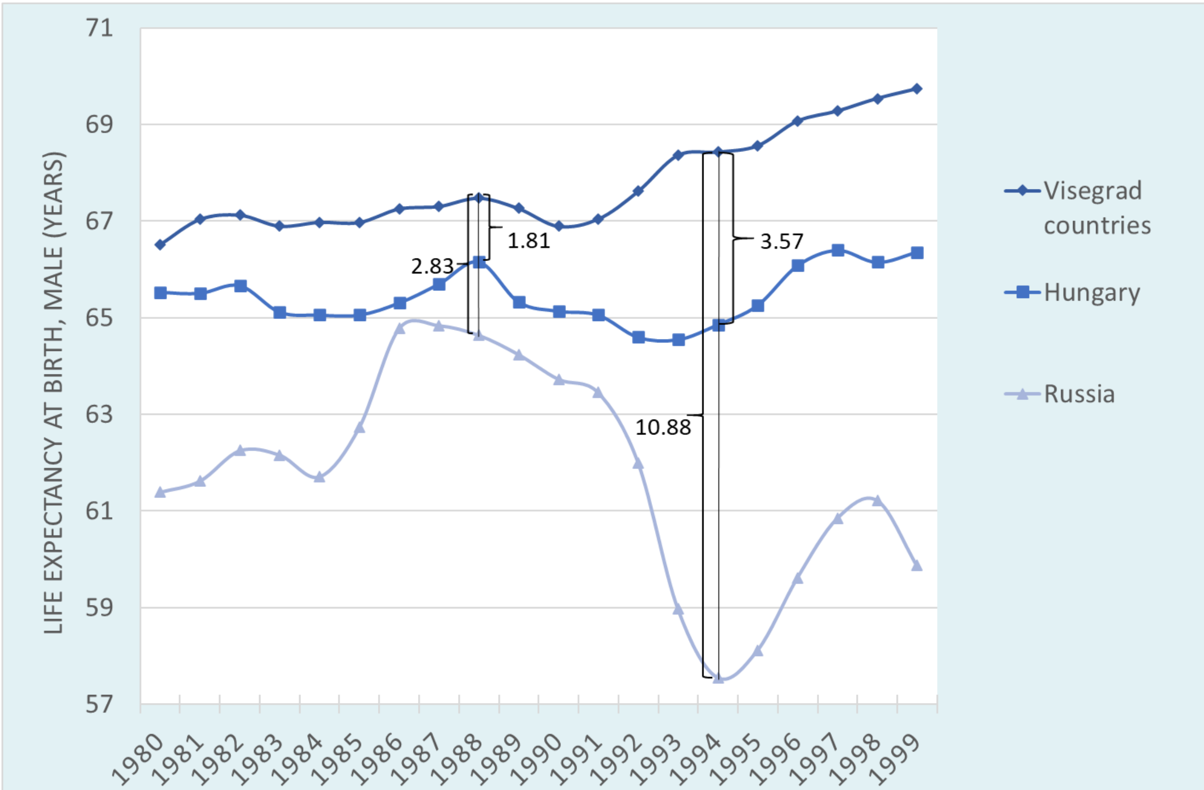
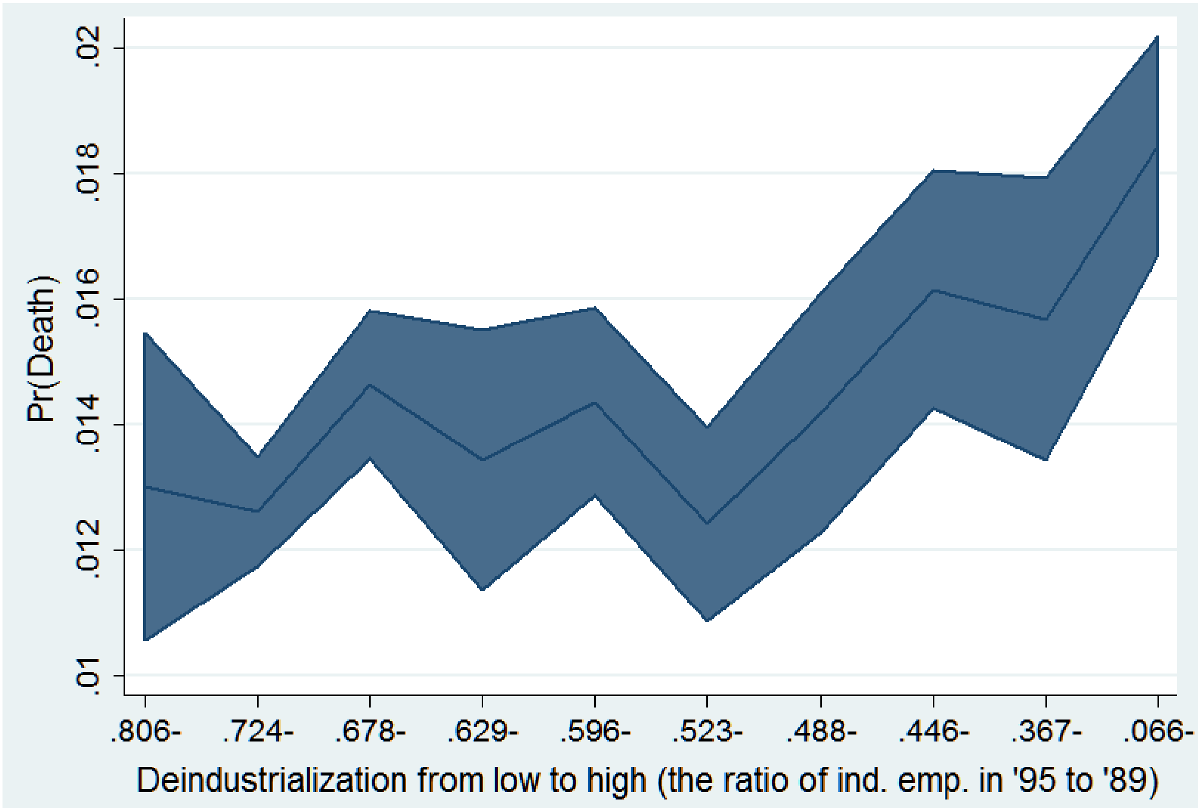
Tables and Figures

Figure 1. Postsocialist mortality crisis in Hungary and Russia



Notes: Visegrád countries' average includes the Czech Republic, Poland, and Slovakia (excludes Hungary).
Source: (WHO 2017)

Figure 2. Predicted probability of men's mortality by deindustrialization in Hungary (1989-1995)



Notes: The lower the ratio of industrial employment from 1995 to 1989, the higher the level of deindustrialization. The dependent variable is binary, indicating the death of subjects between 1989 and 1995. To calculate predicted probabilities, we used standard logistic regression with clustered standard errors. We grouped towns into deciles (the number of towns in each category was between 5 and 6). The model follows the specification of model 4, Table 4: the primary independent variable is deindustrialization, plus town-level control variables (total death rate in 1989, average unemployment in 1990-1995, and average dependency ratio 1989-1995), and individual-level controls (smoking, alcohol intake, education, and marital status).

Figure 3. Deindustrialization and male mortality in Hungary (1989-1995)

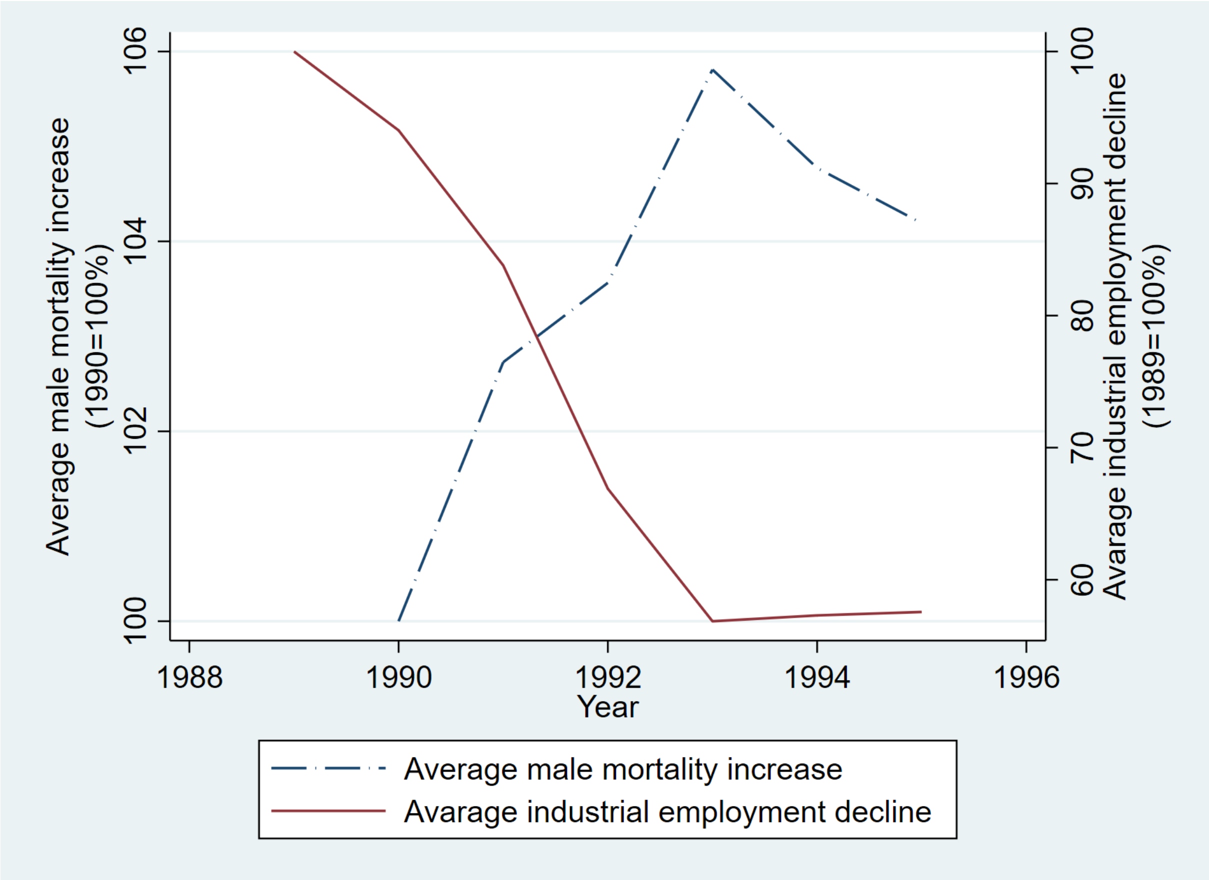


Figure 4. Deindustrialization and mortality in Russia (1981-1999)

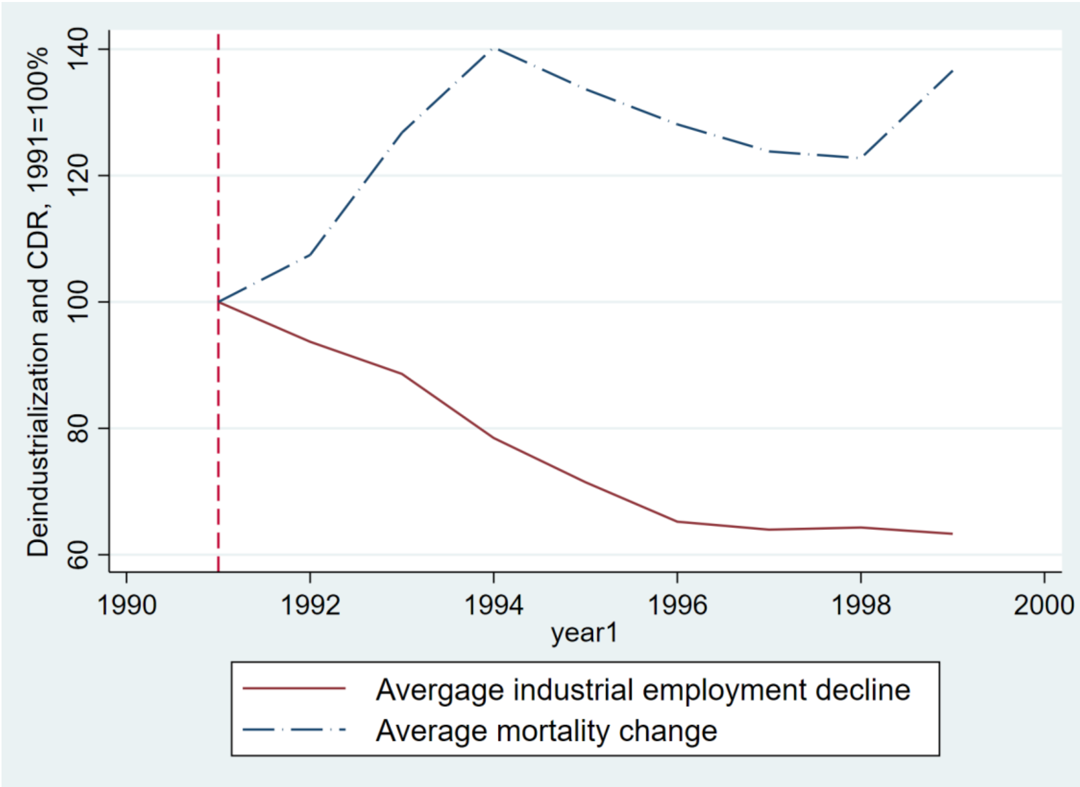


Table 1. Key indicators of labor market transformation in Hungary

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Population (million)	10.75	10.75	10.72	10.67	10.62	10.57	10.52	10.48	10.44	10.40
Total employment (million)	5.15	5.36	5.32	5.26	5.21	5.17	5.14	5.11	5.15	5.14
Employment change (year on year)		4.1%	-0.9%	-1.0%	-1.0%	-0.8%	-0.5%	-0.6%	0.8%	-0.2%
Manufacturing employment (million)	1.61	1.58	1.54	1.49	1.48	1.50	1.49	1.45	1.41	1.36
Manufacturing employment change (year-on-year)		-2.2%	-2.4%	-3.4%	-0.7%	1.2%	-0.7%	-2.2%	-3.2%	-3.7%
Unemployment rate %										
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Population (million)	10.38	10.36	10.36	10.36	10.36	10.35	10.33	10.31	10.28	10.25
Total employment (million)	5.07	4.79	4.39	4.11	4.03	4.02	4.02	4.03	4.09	4.20
Employment change (year on year)	-1.4%	-5.5%	-8.4%	-6.3%	-1.9%	-0.3%	0.1%	0.1%	1.5%	2.8%
Manufacturing employment (million)	1.28	1.05	0.94	0.89	0.85	0.85	0.86	0.91	0.93	
Manufacturing employment change (year-on-year)	-5.5%	-18.1%	-10.7%	-5.2%	-4.3%	0.1%	1.6%	5.6%	1.9%	
Unemployment rate %	1.7	9.70	9.94	12.10	10.85	10.17	10.02	8.99	8.93	6.93

Sources:
Population, Employment, Real GDP growth rate %: Feenstra et al. (2019)
Manufacturing employment: Brada et al. (1994) and Laky (2000)
SDR, male: WHO (2020)
Unemployment rate (World Bank 2020): 1990- national estimate, 1991- ILO modeled estimate
Manufacturing employment incl mining, excluding construction

Table 2. Key indicators of labor market transformation in Russia

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Population (million)[1]	138.4	139.2	140	141	142.1	143.1	144.1	145.3	146.4	147.4
Total employment (million)[1]	73.27	73.73	74.16	74.49	74.59	74.94	75.21	75.16	74.98	75.17
Employment change (year on year)		0.6%	0.6%	0.4%	0.1%	0.5%	0.4%	-0.1%	-0.2%	0.3%
Industrial employment (million)[2]	23.81	23.75	23.63	23.49	23.26	23.1	23.11	22.97	22.39	21.87
Industrial employment change (year-on-year), %		-0.3%	-0.5%	-0.6%	-1.0%	-0.7%	0.0%	-0.6%	-2.5%	-2.3%
Unemployment rate %										

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Population (million)[3]	148	148.3	148.4	148.4	148.3	148.1	147.8	147.4	146.9	148.04
Total employment (million)[3]	75.3	73.8	72.1	70.9	68.5	66.4	66	64.7	63.8	63.96
Employment change (year on year), %	0.2%	-2.0%	-2.3%	-1.7%	-3.4%	-3.1%	-0.6%	-2.0%	-1.4%	0.3%
Industrial employment (million)[3]	22.81	22.41	21.32	20.81	18.58	17.16	16.37	14.91	14.16	14.3
Industrial employment change (year-on-year)	4.3%	-1.8%	-4.9%	-2.4%	-10.7%	-7.6%	-4.6%	-8.9%	-5.0%	1.0%
Unemployment rate %[4]		5.1%	5.2%	5.9%	8.1%	9.5%	9.7%	11.8%	13.3%	13.0%

Sources:
Goskomstat Rossii. 1980–1989. *Rossiiskii statisticheskii ezhegodnik*. Moscow: Goskomstat.
Estimated from: *Obzor zanyatosti Rossii (1991-2000)*, Issue 1, 2002. Moscow: Teis; Goskomstat SSSR. 1980–1989. *Narodnoe khoziaistvo RSFSR: statisticheskii ezhegodnik*. Moscow: Goskomstat.
Goskomstat Rossii. 1990–2000. *Rossiiskii statisticheskii ezhegodnik*. Moscow: Goskomstat
Estimated from: *Obzor zanyatosti Rossii (1991-2000)*, Issue 1, 2002. Moscow: Teis

Table 3. Deindustrialization and male mortality in Hungary (1989-1995), multilevel survival models

Dependent variable	death of subjects between 1989 and 1995			
	(1)	(2)	(3)	(4)
Severe deindustrialization (≥50%)	1.196***	1.126*	1.193***	1.214***
	(0.051)	(0.062)	(0.060)	(0.061)
Education: Secondary		0.865**		0.862**
		(0.040)		(0.040)
Education: Tertiary		0.688***		0.684***
		(0.065)		(0.065)
Smoking: Regularly		1.508***		1.515***
		(0.057)		(0.057)
Alcohol: Frequently (daily or several times a week)		1.228***		1.231***
		(0.043)		(0.042)
Marital status: Divorced/separated		1.012		1.009
		(0.073)		(0.073)
Marital status: Widower		0.516***		0.516***
		(0.035)		(0.035)
Average number of inhabitants in 1989-1995			1.000	1.000
			(0.000)	(0.000)
Average unemployment rate in 1990-1995			0.989	0.983*
			(0.008)	(0.007)
Average dependency ratio 90-94			1.004	1.004
			(0.003)	(0.003)
Death rate in 1989			1.000	1.000
			(0.000)	(0.000)
Constant	0.001***	0.001***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Notes: Multilevel survival models with random slopes for deindustrialization. All models include additional controls for each year after 1989, subjects' relationship status to the respondent, and subjects' age in 1989. Reference categories for categorical variables: Deindustrialization: Moderate (<50%); Education: Primary; Alcohol: Occasionally; Smoking: Quit or never; Marital status: Married. Cluster-robust SEs in parentheses.

Table 4. Pre-existing male mortality differentials in Hungary among deindustrialized towns (1985-1988), multilevel survival models

Dependent variable	death of subjects between 1985 and 1988			
	(1)	(2)	(3)	(4)
Severe deindustrialization (89-95) (≥50%)	1.042	1.000	1.087	1.077
	(0.071)	(0.071)	(0.091)	(0.098)
Education: Secondary		0.816***		0.813***
		(0.042)		(0.042)
Education: Tertiary		0.593***		0.589***
		(0.066)		(0.067)
Smoking: Regularly		1.434***		1.438***
		(0.089)		(0.089)
Alcohol: Frequently (daily or several times a week)		1.229***		1.231***
		(0.071)		(0.071)
Marital status: Divorced/separated		1.000		1.000
		(.)		(.)
Marital status: Widower		0.484***		0.486***
		(0.037)		(0.037)
Average number of inhabitants in 1989-1995			1.000	1.000
			(0.000)	(0.000)
Average unemployment rate in 1990-1995			0.979	0.976
			(0.015)	(0.016)
Average dependency ratio 90-94			1.010	1.006
			(0.009)	(0.010)
Constant	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Notes: Multilevel survival models with random slopes for deindustrialization. The dependent variable is binary, indicating the death of subjects between 1985 and 1988. All models include additional controls for each year between 1985-1988, subjects' relationship status to the respondent, and subjects' age in 1985. Reference categories for categorical variables: Deindustrialization: Moderate (<50%); Education: Primary; Alcohol: Occasionally; Smoking: Quit or never; Marital status: Married. Cluster-robust SEs in parentheses.

Table 5. Deindustrialization and male mortality in Hungary (1989-1995), town-level fixed-effects panel models

Dependent variable	town-level annual male death rate per 100,000			
	(1)	(2)	(3)	(4)
Deindustrialization (%)	1.193*	1.526*	1.697**	1.737**
	(0.580)	(0.581)	(0.578)	(0.589)
Income per capita (10000 HUF)		8.720		1.663
		(6.339)		(7.010)
Unemployment		-0.344		-0.256
		(2.480)		(2.618)
Number of inhabitants			-0.000	-0.000
			(0.010)	(0.010)
Dependency ratio			-13.201**	-12.444*
			(4.592)	(5.343)
Out-migration per inhabitant			138.105	179.581
			(1170.054)	(1194.949)
No of GPs per inhabitant			84955.956	75593.037
			(113135.912)	(118961.725)
Constant	644.139***	580.270***	1590.526***	1529.622**
	(13.109)	(51.028)	(444.867)	(484.484)
No. of observations[town-years]	310	310	310	310
No. of groups[towns]	52	52	52	52

* p<0.05, ** p<0.01, *** p<0.001

Notes: Deindustrialization is defined as the cumulative change in the industrial employment-to-population ratio (1989 as baseline). All models include controls for year fixed effects (year dummies)—Cluster-robust SEs in parentheses.

Table 6. Deindustrialization and mortality in Russia (1991-1999), town-level fixed-effects panel models

Dependent variable	town-level annual death rate per 100,000				
	(1)	(2)	(3)	(4)	(5)
Deindustrialization (%)	0.407***	0.404***	0.526***	0.431***	0.520***
	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)
Income per capita (in 1991 roubles)		0.103***			0.148***
		(0.03)			(0.03)
Floor area per person		1.257			0.656
		(1.04)			(1.06)
Number of inhabitants			-0.004***		-0.004***
			(0.00)		(0.00)
Dependency ratio			1.532***		1.420***
			(0.4)		(0.41)
Net migration per person			-2905.4		-3858.7
			(3246)		(3296)
Physicians per 100,000				-0.640	-0.419
				(0.43)	(0.44)
Hospital beds, per 10,000				0.064	-0.012
				(0.09)	(0.1)
Constant	1193.1***	1142.9***	1207.4***	1207.26***	1171.074***
	(5.7)	(15.0)	(44.1)	(17.0)	(49.6)
No. of observations[town-years]	4527	4467	4107	4310	3965
No. of groups[towns]	514	513	496	513	492

* p<0.05, ** p<0.01, *** p<0.001

Notes: Deindustrialization is defined as the cumulative change in the industrial employment-to-population ratio (1991 as baseline). All models include controls for year fixed effects (year dummies)—Cluster-robust SEs in parentheses.

Table 7. Deindustrialization and alcohol consumption in Russia (1991-1999), town-level fixed-effects panel models

Dependent variable	regional level annual alcohol consumption (liters of pure alcohol per capita)		
	(1)	(2)	(3)
Deindustrialization (%)	-0.013***		-0.013**
	(4e-3)		(4e-3)
Alcohol price, deflated		8e-6	0.017**
		(5e-5)	(-6e-3)
Income per capita (in 1991 rubles)			5e-4*
			(2e-4)
Number of inhabitants			-0.392
			(0.44)
Floor area per person			0.01
			(0.01)
Constant	5.178***	4.939***	4.626***
	(0.08)	(0.04)	(0.27)
No. of observations[town-years]	4532	4589	4417
No. of groups[towns]	514	514	513

* p<0.05, ** p<0.01, *** p<0.001

Notes: Deindustrialization is defined as the annual industrial employment-to-population ratio in percent. All models include controls for year fixed effects (year dummies)—Cluster-robust SEs in parentheses.

Table 8. Deindustrialization, alcohol consumption and mortality in Russia (1991-1999), non-standardized and standardized values

Dependent variable	town-level annual death rate per 100,000			
	Non-standardized values		Standardized values	
	(1)	(2)	(3)	(4)
Deindustrialization (%)	0.523***		24.72***	
	(0.09)		(4.28)	
Alcohol consumption, liters per person		10.67***		26.00***
		(2.5)		(0.03)
No. of observations[town-years]	4023	4023	4023	4023
No. of groups[towns]	492	492	492	492

* p<0.05, ** p<0.01, *** p<0.001

Notes: Deindustrialization is defined as the cumulative change in the industrial employment-to-population ratio (1991 as baseline). All models include controls for year fixed effects (year dummies), income per capita in 1991 rubles, number of inhabitants, floor area per person, dependency ratio, number of physicians per 100,000, and number of hospital beds per 10,000—Cluster-robust SEs in parentheses.

Appendix

Figure A1. Age-specific death rates in Hungary and Russia

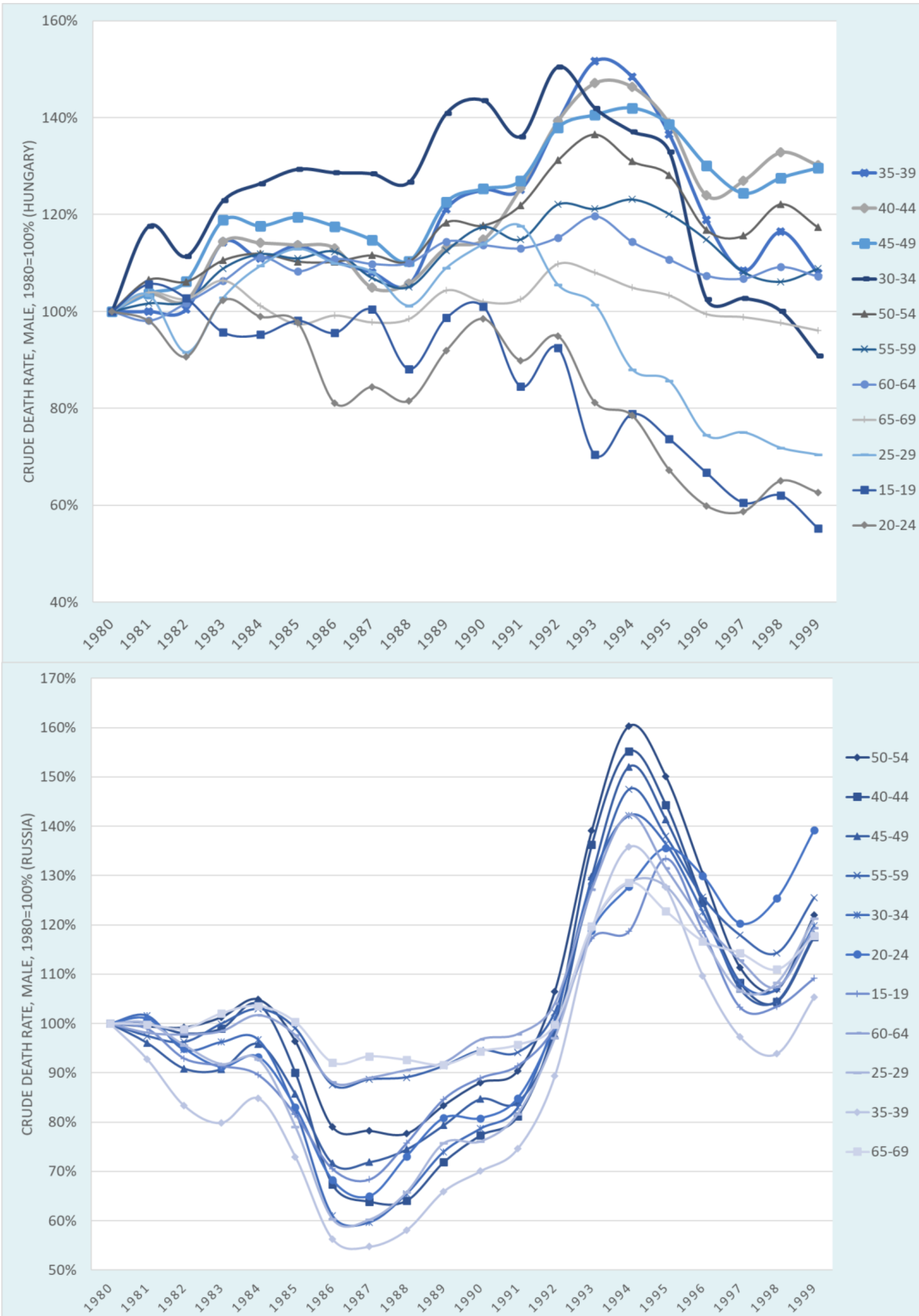
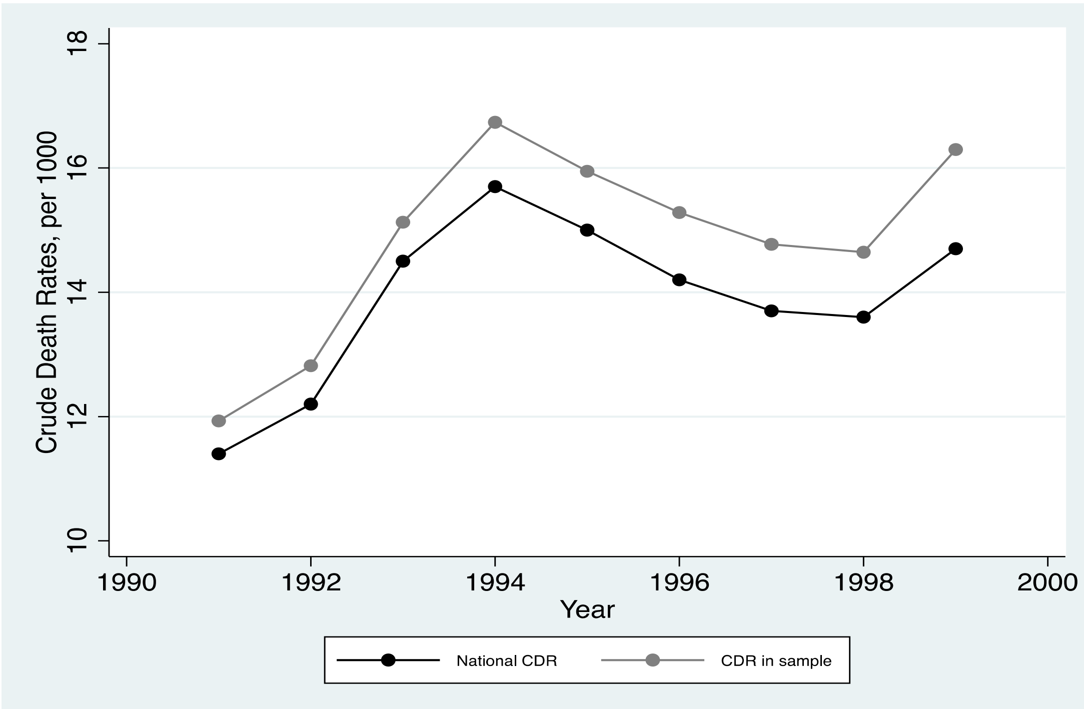


Figure A2. Crude Death Rates in the Russian Federation and a sample of 514 towns, 1991-1999



Notes: Official national crude death rates (per 1,000 population) plotted from 1991 to 1999 in black connected dots, available in annual statistical yearbooks published by Goskomstat and Rosstat. Estimates of crude death rates in our sample of 514 middle-size towns are represented in gray connected dots. They are retrieved from the Database «Economics of Russian cities" provided by the Main Interregional Center of the Processing and Dissemination of Statistical information of the Federal State Statistics Service (GMC Rosstat)

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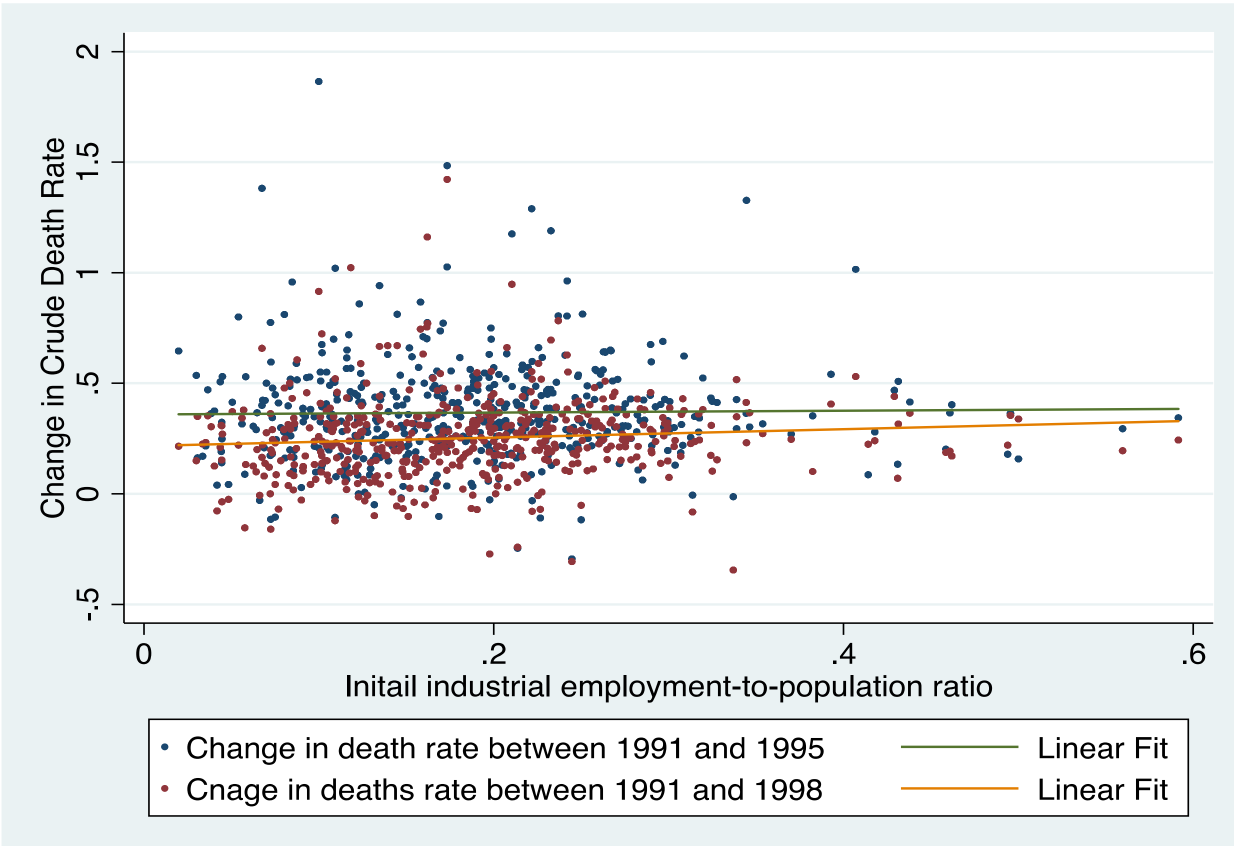
Figure A3. Change in crude death rates between 1991-1995 and 1991-1998 and the initial level of the industrial employment-to-population ratio



Note: Scatterplot of blue dots show the association between the changes in death rates, defined as the change in deaths per 1000 in 1995 relative to the death rate in 1991, and the initial level of industrialization, defined as the industrial employment-to-population ratio in 1991. The fitted green line is a superimposed linear regression line for these two variables. Scatter of red dots represent the association between the change in death rate in 1998 relative to the death rate in 1991, with a yellow line representing a linear regression line for these two variables.

Table A1. Cause-specific standardized male mortality rates in Hungary, 1980-1999

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SDR, all causes	1666.8	1647.3	1646.8	1699.4	1683.3	1680.5	1653.5	1607.5	1566.3	1625.2	1669.0	1660.4	1713.8	1731.5	1678.1	1639.7	1581.1	1540.8	1553.7	1608.8
Change (1980=100%)		98.8%	98.8%	102.0%	101.0%	100.8%	99.2%	96.4%	94.0%	97.5%	100.1%	99.6%	102.8%	103.9%	100.7%	98.4%	94.9%	92.4%	93.2%	96.5%
Diseases of circ. system	843.3	833.5	845.2	855.6	846.3	851.8	820.2	793.5	772.8	785.7	806.3	801.4	804.0	816.4	768.4	752.5	738.3	711.9	721.4	744.5
Change (1980=100%)		98.8%	100.2%	101.5%	100.4%	101.0%	97.3%	94.1%	91.6%	93.2%	95.6%	95.0%	95.3%	96.8%	91.1%	89.2%	87.6%	84.4%	85.5%	88.3%
Ischemic heart disease	130.3	141.5	142.8	141.2	141.3	138.8	140.4	135.6	135.4	132.5	136.3	138.9	140.5	142.6	131.4	131.6	123.0	117.4	117.7	118.9
Change (1980=100%)		108.6%	109.6%	108.4%	108.5%	106.5%	107.7%	104.1%	103.9%	101.7%	104.6%	106.6%	107.9%	109.4%	100.9%	101.0%	94.4%	90.1%	90.3%	91.2%
Malignant neoplasms	313.1	319.6	322.1	326.9	332.5	330.0	345.8	347.1	349.3	356.1	369.5	376.3	386.2	381.3	385.9	386.2	391.1	391.1	390.0	401.8
Change (1980=100%)		102.1%	102.9%	104.4%	106.2%	105.4%	110.5%	110.9%	111.6%	113.7%	118.0%	120.2%	123.3%	121.8%	123.3%	123.3%	124.9%	124.9%	124.6%	128.3%
Alcohol-related causes	278.1	285.5	284.5	308.5	316.3	324.9	315.9	314.7	306.2	336.6	354.3	356.3	386.0	390.5	390.9	376.8	280.7	275.7	282.8	289.3
Change (1980=100%)		102.7%	102.3%	111.0%	113.7%	116.9%	113.6%	113.2%	110.1%	121.0%	127.4%	128.1%	138.8%	140.4%	140.6%	135.5%	100.9%	99.1%	101.7%	104.0%
Injury and poisoning	161.6	162.3	160.6	170.1	170.0	174.5	167.5	165.2	156.4	165.7	177.0	170.8	174.9	165.3	160.1	149.6	141.4	135.4	139.1	141.0
Change (1980=100%)		100.5%	99.4%	105.3%	105.2%	108.0%	103.7%	102.2%	96.8%	102.5%	109.5%	105.7%	108.3%	102.3%	99.1%	92.6%	87.5%	83.8%	86.1%	87.3%
Diseases of digestive system	85.5	91.9	89.2	102.5	104.3	103.5	101.3	101.5	98.7	113.9	115.4	119.8	146.3	162.2	165.1	160.9	134.3	131.7	139.9	139.3
Change (1980=100%)		107.5%	104.3%	119.9%	121.9%	121.1%	118.5%	118.7%	115.4%	133.1%	134.9%	140.1%	171.1%	189.7%	193.0%	188.1%	157.1%	153.9%	163.6%	162.8%
Chronic liver disease	42.0	48.5	48.2	59.5	66.5	66.1	64.8	67.2	65.3	77.0	76.7	83.8	106.6	122.9	128.4	125.5	98.5	97.7	104.1	105.4
Change (1980=100%)		115.5%	114.7%	141.6%	158.2%	157.4%	154.2%	159.9%	155.4%	183.2%	182.6%	199.4%	253.6%	292.5%	305.7%	298.7%	234.4%	232.6%	247.8%	250.8%
Suicide and self-injury	67.3	66.3	64.9	69.8	70.1	69.4	68.1	68.0	59.6	62.7	61.3	58.7	59.9	55.5	55.6	50.1	50.8	48.2	49.4	52.4
Change (1980=100%)		98.6%	96.5%	103.8%	104.2%	103.2%	101.2%	101.0%	88.6%	93.2%	91.1%	87.2%	89.1%	82.5%	82.6%	74.5%	75.5%	71.7%	73.4%	77.8%
Infant deaths per 1000 births	23.2	20.8	20.0	19.1	20.4	20.4	19.1	17.3	15.8	15.7	14.8	15.6	14.1	12.5	11.6	10.7	10.9	9.9	9.7	8.4
Change (1980=100%)		89.8%	86.5%	82.3%	88.1%	87.9%	82.3%	74.7%	68.4%	68.0%	64.0%	67.5%	60.8%	53.8%	49.9%	46.0%	47.1%	42.6%	41.9%	36.4%
Infectious diseases	20.9	20.7	19.3	19.8	17.4	15.4	14.2	15.9	14.1	15.7	13.7	13.1	13.2	13.7	12.2	12.1	11.3	9.9	10.2	10.2
Change (1980=100%)		98.7%	92.4%	94.8%	83.0%	73.6%	67.7%	75.7%	67.5%	74.9%	65.5%	62.4%	63.2%	65.6%	58.2%	57.6%	53.9%	47.4%	48.5%	48.7%
Tuberculosis	16.8	15.3	13.8	13.7	11.4	9.6	9.6	9.3	8.0	8.7	8.6	8.3	9.4	10.0	9.0	8.8	8.9	7.6	7.2	7.2
Change (1980=100%)		91.0%	82.0%	81.5%	68.0%	57.2%	57.2%	55.0%	47.3%	51.6%	51.1%	49.5%	55.9%	59.6%	53.4%	52.0%	52.9%	45.0%	42.6%	43.0%
Mental disorders	3.7	6.0	5.8	8.1	10.8	9.6	10.1	10.1	12.5	14.6	14.7	14.3	19.6	23.6	25.6	25.6	17.3	19.6	16.4	19.6
Change (1980=100%)		163.0%	156.5%	219.8%	292.1%	260.1%	274.7%	274.5%	338.6%	397.8%	399.5%	389.1%	531.3%	641.6%	696.2%	694.6%	470.7%	533.2%	446.5%	532.9%
Homicide	3.5	3.3	3.1	3.2	3.7	3.3	3.6	3.2	3.6	3.5	4.3	5.4	5.3	5.2	5.0	5.0	3.9	4.2	4.1	3.6
Change (1980=100%)		94.5%	89.6%	91.3%	106.7%	95.7%	104.6%	93.3%	104.3%	100.9%	123.8%	155.7%	152.5%	151.0%	145.8%	143.5%	112.2%	122.3%	118.0%	102.9%

Note:
All indicators are SDR per 100,000 males, all ages (except ischemic heart disease mortality, which is for ages 0-64, and infant deaths).

Table A2. Cause-specific standardized male mortality rates in Russia, 1980-1999

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
SDR, all causes	1866.4	1829.2	1770.3	1806.5	1872.7	1802.5	1621.2	1627.0	1636.4	1643.6	1688.3	1699.0	1803.7	2145.2	2305.8	2170.2	2012.1	1907.2	1854.7	1999.4
Change (1980=100%)		98.0%	94.8%	96.8%	100.3%	96.6%	86.9%	87.2%	87.7%	88.1%	90.5%	91.0%	96.6%	114.9%	123.5%	116.3%	107.8%	102.2%	99.4%	107.1%
Diseases of circ. system	945.4	923.0	901.0	929.6	971.2	949.7	876.9	883.3	875.9	854.3	863.4	855.4	881.7	1050.2	1138.5	1051.7	983.3	948.7	928.4	1006.5
Change (1980=100%)		97.6%	95.3%	98.3%	102.7%	100.5%	92.8%	93.4%	92.6%	90.4%	91.3%	90.5%	93.3%	111.1%	120.4%	111.2%	104.0%	100.3%	98.2%	106.5%
Ischemic heart disease	169.5	163.4	162.8	166.9	172.8	162.1	146.2	149.7	147.4	152.2	161.1	160.8	178.1	231.2	267.2	239.3	213.6	191.9	187.8	208.2
Change (1980=100%)		96.4%	96.0%	98.5%	102.0%	95.7%	86.3%	88.3%	87.0%	89.8%	95.1%	94.9%	105.1%	136.4%	157.7%	141.2%	126.1%	113.3%	110.8%	122.8%
Malignant neoplasms	281.1	282.7	286.7	291.6	294.6	295.8	303.0	306.8	310.6	313.5	315.0	316.3	316.5	321.9	316.1	306.5	297.2	293.9	290.2	291.0
Change (1980=100%)		100.6%	102.0%	103.7%	104.8%	105.2%	107.8%	109.1%	110.5%	111.5%	112.1%	112.5%	112.6%	114.5%	112.5%	109.0%	105.7%	104.5%	103.2%	103.5%
Injury and poisoning	272.9	271.5	255.1	169.7	175.6	222.0	174.1	170.8	185.9	214.5	228.2	242.1	293.4	383.1	418.7	394.5	347.2	309.6	306.4	336.3
Change (1980=100%)		99.5%	93.5%	62.2%	64.4%	81.4%	63.8%	62.6%	68.1%	78.6%	83.6%	88.7%	107.5%	140.4%	153.4%	144.6%	127.2%	113.5%	112.3%	123.3%
Suicide and self-injury	63.7	63.7	64.0			57.2	40.7	41.6	43.2	46.6	47.5	47.6	55.8	69.4	76.8	74.4	71.0	66.9	62.5	69.0
Change (1980=100%)		100.0%	100.5%			89.9%	64.0%	65.4%	67.8%	73.3%	74.6%	74.8%	87.6%	109.0%	120.7%	117.0%	111.5%	105.1%	98.2%	108.3%
Diseases of digestive system	52.8	50.6	49.8	52.0	53.4	50.6	44.1	44.7	43.3	43.3	44.1	44.2	50.1	58.1	65.7	68.8	62.6	56.9	54.7	60.0
Change (1980=100%)		95.9%	94.2%	98.4%	101.1%	95.8%	83.5%	84.6%	81.9%	81.9%	83.5%	83.7%	94.8%	110.0%	124.4%	130.2%	118.5%	107.6%	103.6%	113.6%
Infant deaths per 1000 births	22.0	21.5	20.2	19.9	21.1	20.8	19.1	19.4	19.1	18.1	17.6	18.1	18.4	20.7	18.8	18.2	17.5	17.3	16.4	17.1
Change (1980=100%)		97.5%	91.6%	90.1%	95.6%	94.4%	86.9%	88.1%	86.7%	82.0%	80.1%	82.2%	83.6%	94.0%	85.6%	82.7%	79.5%	78.3%	74.7%	77.5%
Infectious diseases	39.3	35.0	32.5	31.1	31.6	30.3	24.7	23.7	22.9	22.8	22.0	21.8	24.5	32.5	37.1	38.0	39.7	38.1	34.6	44.4
Change (1980=100%)		89.1%	82.6%	78.9%	80.4%	77.0%	62.7%	60.2%	58.3%	57.9%	55.9%	55.5%	62.2%	82.6%	94.3%	96.6%	100.9%	96.7%	88.0%	113.0%
Tuberculosis	27.7	23.8	22.3	21.6	22.2	21.6	17.3	16.9	16.5	16.9	17.0	17.0	19.4	25.9	29.5	30.7	33.5	32.5	29.3	37.8
Change (1980=100%)		85.7%	80.3%	77.8%	80.1%	78.0%	62.4%	60.8%	59.3%	60.8%	61.1%	61.1%	69.9%	93.2%	106.2%	110.6%	120.6%	117.2%	105.8%	136.4%
Homicide	19.3	19.3	18.5			15.2	10.7	11.4	14.7	19.5	22.4	24.1	36.4	47.9	50.6	47.9	40.7	36.7	34.7	39.5
Change (1980=100%)		100.2%	95.8%			78.7%	55.3%	58.9%	76.1%	101.2%	115.8%	124.6%	188.6%	247.9%	262.1%	247.9%	210.9%	189.9%	179.7%	204.6%
Mental disorders	6.6	7.3	6.6	6.4	6.7	5.9	3.7	3.1	2.6	2.9	3.8	3.9	5.2	9.8	15.5	16.7	11.4	8.0	7.0	7.6
Change (1980=100%)		110.6%	99.8%	97.0%	101.4%	90.1%	55.7%	47.3%	40.1%	43.7%	57.5%	59.0%	79.5%	148.3%	235.1%	252.8%	172.2%	121.9%	105.9%	114.6%

Note:
All indicators are SDR per 100,000, males, all ages (except ischemic heart disease mortality, which is for ages 0-64, and infant deaths).
For Russia, the WHO does not report alcohol-related deaths, including chronic liver diseases and cirrhosis.

Table A3. Description of individual-level variables (men only), Hungary

	N	%
Total males	24,377	100.00%
Number of deceased 1989-1995	3,583	100.00%
Education: Primary (ref.cat.)	9,963	100.00%
Education: Secondary	12,491	100.00%
Education: Tertiary	1,709	100.00%
Alcohol: Occasionally (abstainer or 1-4 times a month) (ref.cat.)	18,363	100.00%
Alcohol: Frequently (daily or several times a week)	5,697	100.00%
Smoking: Quit or never (ref.cat.)	14,318	100.00%
Smoking: Regularly	9,837	100.00%
Marital status: Married (ref.cat.)	18,871	100.00%
Marital status: Divorced/separated	2,309	100.00%
Marital status: Widower	2,253	100.00%

Source: PrivMort database (Irdam et al. 2016)

Table A4. Description of town-level variables, Hungary

Town-level variables	Total (N=52)			
	Mean	Std. Dev.	Min	Max
Industrial employment loss 1989-1995	41%	18	0%	93%
Average unemployment rate in 1990-1995	8.68%	3.39	2%	19%
Average income per capita in 1990-1995	102.12	21.93	56.67	168
Death rate in 1989	1171.64	229.15	632.06	1917.99
Average dependency rate in 1989-1995	72.49%	4.89	63.6%	83.67%
Average outmigration in 1989-1995	1060.46	911.10	174.67	3612.17
Average number of inhabitants in 1989-1995	25993	21624	5151	86474
Average number of GPs in 1989-1995	9.94	8.12	2	37
Average age in 1989	51.03	16.81	0	100

Notes:
Unemployment: The average number of those willing to work but unable to find a job divided by the total number of economically active between 1990 and 1994 expressed as a percent
Income per capita: Average nominal personal income tax base per 1 permanent inhabitant in thousand forints between 1990 and 1994
Death rate: Total number of deceased men and women divided by the size of the population in 1989 per 100,000
Dependency ratio: The average number of dependents (aged zero to 14 and over the age of 65) divided by the working-age population (aged 15 to 64) between 1989 and 1994 expressed as a percent
Outmigration: The average number of persons who were permanently changing residency out of the town between 1989 and 1994
Number of inhabitants: The average number of people living in the town at the beginning of the year in thousand between 1989 and 1994
Number of GPs: Total average number of general practitioners registered in the town between 1989 and 1994 per 100,000 inhabitants
Age in 1989: The average age of the subjects included in the analysis in 1989, the average value per town of an individual-level variable

Table A5. Description of ecological-level variables, Russia

		Total (N=514)			
Variables	Level	Mean	Std. Dev.	Min	Max
Industrial employment loss between 1992-1999	Town	28.22	59.31	-619.4	98.15
Average income per capita in 1991-1999	Town	291.05	108.32	52.81	958.54
Average alcohol consumption in 1991-1999	Region	6.65	1.29	3.95	10.91
Average price of alcohol, in 1991	Region	20.66	91.10	9.74	2081.83
Death rate in 1991, per 1,000	Town	16.53	4.19	3	43
Average dependency rate in 1991-1999	Town	77.01	9.47	46.76	112.23
Average number of inhabitants in 1991-1999	Town	40906.52	29495.56	4100	154133
Average floor area per capita 1991-1999	Town	18.39	2.33	10.57	31.82
Average net migration per 1,000 in 1991-1999	Town	5.26	6.73	-30.01	55.69
Average number of GPs per 100,000 in 1991-1999	Town	35.36	10.12	13.47	94.13
Average number of hospital beds per 10,000 in 1991-1999	Town	142.84	52.40	25.88	491.11

Notes:
Industrial employment loss: cumulative change in the industrial employment-to-population ratio between 1992 and 1999 (1991 as baseline), in percent
Average alcohol consumption: the average number of liters per capita consumed in the region between 1991-1999
Average price of alcohol: the average price of alcohol in rubles deflated to 1991year in the capital city of the region, between 1991 and 1999
Average income per capita: the average wage deflated to 1991 per inhabitant between 1991 and 1999
Death rate in 1991: total number of deceased persons divided by the size of the population in 1991 per 1,000
Average dependency ratio: the average number of dependents (aged zero to 14 and over the age of 65) divided by the working-age population (aged 15 to 64) between 1991 and 1999
Average number of inhabitants: the average number of people living in the town at the beginning of the year between 1991 and 1999
Average net migration: the average number of net migration in and out of town per 1,000 inhabitants in 1991-1999
Average number of GPs: the average number of general practitioners registered in the town between 1991 and 1999 per 100,000 inhabitants
Average number of hospital beds: the average number of hospital beds in the town between 1991 and 1999 per 10,000 inhabitants

Table A6. Deindustrialization and female mortality in Hungary (1989-1995), multilevel survival models

Dependent variable	death of subjects between 1989 and 1995			
	(1)	(2)	(3)	(4)
Severe deindustrialization (≥50%)	0.963	0.969	1.020	1.028
	(0.050)	(0.055)	(0.056)	(0.067)
Education: Secondary		0.858		0.852
		(0.070)		(0.070)
Education: Tertiary		0.989		0.978
		(0.153)		(0.153)
Smoking: Regularly		1.610***		1.618***
		(0.156)		(0.156)
Alcohol: Frequently (daily or several times a week)		2.036**		2.022**
		(0.464)		(0.460)
Marital status: Divorced/separated		0.643***		0.640***
		(0.085)		(0.084)
Marital status: Widow		0.614***		0.614***
		(0.034)		(0.034)
Average number of inhabitants in 1989-1995			1.000	1.000
			(0.000)	(0.000)
Average unemployment rate in 1990-1995			0.987	0.991
			(0.011)	(0.012)
Average dependency ratio 90-94			1.008	1.003
			(0.008)	(0.008)
Death rate in 1989			1.000	1.000
			(0.000)	(0.000)
Constant	0.001***	0.001***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)

* p<0.05, ** p<0.01, *** p<0.001

Notes: Multilevel survival models with random intercepts. All models include additional controls for each year after 1989, subjects' relationship status to the respondent, and subjects' age in 1989. Reference categories for categorical variables: Deindustrialization: Moderate (<50%); Education: Primary; Alcohol: Occasionally; Smoking: Quit or never; Marital status: Married. Cluster-robust SEs in parentheses.

Table A7. Deindustrialization and male mortality in Hungary (1989-1995), multilevel survival models with additional town-level control variables

Dependent variable	death of subjects between 1989 and 1995						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Severe deindustrialization (≥50%)	1.196***	1.184***	1.192***	1.192***	1.195***	1.180***	1.181**
	(0.061)	(0.056)	(0.055)	(0.056)	(0.055)	(0.052)	(0.068)
Average income per capita in 1990-1995	1.000						1.003*
	(0.001)						(0.001)
Average number of GPs in 1989-1995		0.998					0.992
		(0.003)					(0.012)
Average outmigration in 1989-1995			1.000				1.000
			(0.000)				(0.000)
Average outmigration 1996-2015				1.000			1.000
				(0.000)			(0.000)
Average in-migration 1996-2015					1.000		1.000
					(0.000)		(0.000)
Industrial employment % in 1989						0.659	0.565*
						(0.239)	(0.151)
Education: Secondary							0.860**
							(0.040)
Education: Tertiary							0.684***
							(0.064)
Smoking: Regularly							1.513***
							(0.057)
Alcohol: Frequently							1.234***
							(0.043)
Marital status: Divorced/separated							1.008
							(0.073)
Marital status: Widower							0.517***
							(0.035)
Constant	0.001***	0.001***	0.001***	0.001***	0.001***	0.001***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

* p<0.05, ** p<0.01, *** p<0.001

Notes: All models are multilevel survival models with random slopes. All models include additional controls for each year after 1989, subjects' relationship status to the respondent, and subjects' age in 1989. Reference categories for categorical variables: Deindustrialization: Moderate (<50%); Education: Primary; Alcohol: Occasionally; Smoking: Quit or never; Marital status: Married—Cluster-robust SEs in parentheses.

Table A8. Deindustrialization and male mortality stratified by initial levels of industrial employment in Hungary (1989-1995), multilevel survival models

Dependent variable	death of subjects between 1989 and 1995					
	Share of the total population employed in industry in 1989					
	Below median (<21%)			Above median (≥21%)		
	(1)	(2)	(3)	(4)	(5)	(6)
Severe deindustrialization (≥50%)	1.201**	1.285***	1.306***	1.000	1.023	1.021
	(0.071)	(0.063)	(0.060)	(0.084)	(0.104)	(0.085)
Average number of inhabitants in 1989-1995		1.000	1.000		1.000	1.000
		(0.000)	(0.000)		(0.000)	(0.000)
Average unemployment rate in 1990-1995		0.989	0.986		0.983	0.976
		(0.010)	(0.010)		(0.016)	(0.014)
Average dependency ratio 90-94		0.994	0.994		1.018	1.019*
		(0.007)	(0.008)		(0.010)	(0.009)
Death rate in 1989		1.000	1.000		1.000	1.000
		(0.000)	(0.000)		(0.000)	(0.000)
Education: Secondary			0.926			0.796***
			(0.063)			(0.050)
Education: Tertiary			0.594**			0.752**
			(0.109)			(0.071)
Smoking: Regularly			1.554***			1.465***
			(0.074)			(0.090)
Alcohol: Frequently (daily or several times a week)			1.174**			1.291***
			(0.062)			(0.052)
Marital status: Divorced/separated			1.015			1.027
			(0.095)			(0.117)
Marital status: Widower			0.493***			0.551***
			(0.049)			(0.053)
Constant	0.001***	0.002***	0.001***	0.001***	0.000***	0.000***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)

* p<0.05, ** p<0.01, *** p<0.001

Notes: Multilevel survival models with random intercepts. All models include additional controls for each year after 1989, subjects' relationship status to the respondent, and subjects' age in 1989. Reference categories for categorical variables: Deindustrialization: Moderate (<50%); Education: Primary; Alcohol: Occasionally; Smoking: Quit or never; Marital status: Married. Cluster-robust SEs in parentheses.