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Incidence of female suicide in New York City: how important are socioeconomic factors?

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Abstract

Purpose After a steady decline in the incidence of suicide in the last 3 decades of the twentieth century, suicide rates in the US and likewise in New York City (NYC) began to rise. A breakdown of the city's rates by gender reveals that since 2000, suicides among men had held steady while the rate among women had increased in every age group, in divergence from the national pattern of rising rates in both genders. This study considers a broad range of socioeconomic variables to identify those most strongly associated with suicide rates of women in NYC.

Method Drawing on 4 decades of data from the Census Bureau's Current Population Survey, the NYC Department of Health and Mental Hygiene's Vital Statistics and the Federal Bureau of Investigation's Uniform Crime Reporting Program, we use an Autoregressive Distributed Lag (ARDL) model to estimate short and long run relationships between suicide rates in women aged 15–44 and a range of socioeconomic factors.

Results We find a positive aggregate association between women's suicide rates and the unemployment rate, the White percentage of the city's population, the number of forcible rapes reported in the crime statistics, and a negative association between suicide and abortion rates.

Conclusions The results of the study suggest that labor market conditions, rather than societal factors such as marriage or fertility rates affect younger women's suicide rates in NYC. Second, sexual violence against women, found in micro studies to have severe long-term negative effects on victims' mental health is also positively associated with the aggregate suicide rate. Finally, higher abortion rates correspond with lower suicide rates at the city level, but the mechanisms behind this link are not as clear, since micro studies find little association between unwanted pregnancy termination and mental health.

Keywords Suicides in women · New York City · Socio economic variables · Cointegration · ARDL

Purpose of the study

The United States is in the midst of a sustained increase in suicidal behavior, with rates now reaching a 30 year high, 24% greater than the level that prevailed at the turn of the century. Claiming nearly 45,000 lives in the United States annually, suicide is one of the leading causes of preventable death. Most alarming is the lack of evidence pointing to a deceleration; the increase in the rate was about 1% per year till 2006, and then 2% in the years following [1]. Such sustained growth bucks the trend in most OECD countries where suicide rates have been falling over this period [2].

The two loose exceptions where self-harm rates have gone up, namely Great Britain and the Netherlands, still have rates that are substantially below those in the US [3].

Underneath the time variation in the aggregate US suicide rate, certain demographic patterns persist. While rates have been rising for both sexes, men are around three times as likely as women to die by suicide, while women are twice as likely to make suicide attempts. Whites and Native Americans are the most likely groups to commit suicide across genders, and suicide rates increase in middle age and are quite high among the very elderly [4].

The trend in suicides in New York City (NYC) contains both similarities to and differences from the national pattern. First, the temporal pattern in NYC's aggregate suicide rate has broadly mirrored the Nation's, falling through the 1990s and steadily increasing thereafter. During 2000–2007, the average annual increase was 1.7%, and

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2.3% in the years following [5]. However, NYC has a much lower suicide rate being only half of the national average (6.3 vs. 13 per 100,000 people) [5]. The lower NYC level is not atypical of the country's largest population centers, such as Los Angeles (8.0) and Chicago (6.5) [6, 7].

The most significant NYC departure from the national story, however, has been the variance in the suicides by gender. Since 2000, rates among NYC women have increased in every single age category and by 56% overall, while those of men have remained more-or-less the same [5]. Stability in the NYC men's rate is the product of an increasing rate among white male New Yorkers (also evidenced in this demographic nationwide) offset by their declining share of the population. In contrast, the same is not true for women, whose suicide rate has increased at a rate faster than of women nationwide (56 vs. 45% since 2000), even with similar mitigating demographic changes. National figures over this same period show the trends in suicide to be consistent across the genders (with just lower absolute numbers for women), suggesting that perhaps there are forces at play at the city level that are not reflected in the national statistics.

Based upon the seminal work of Case and Deaton [8], the emergent explanation for the rise in suicidal behavior in the US is one of "deaths of despair" among middle-aged, working-class Whites, both men and women, with a high school diploma or less. A creeping social malaise appears to have settled in over this demographic, as evidenced by a turn to alcohol, drugs and suicide. In turn these actions have collectively managed to increase this cohort's mortality rate since the late 1990s, an unanticipated turnaround given the universality of decreasing rates in most of the world. Case and Deaton posit that this self-destructive inclination is borne of a relative stagnation of economic prospects, vis-à-vis not just more-educated peers, but contrasted with past generations of white Americans of similar educational status, who lived more socially grounded lives with greater economic security. Such findings of adverse labor market outcomes raising the likelihood of suicide abound [9–14].

NYC, with its dynamic economy and a large and diverse population stands in stark relief to the deaths-of-despair narrative. More of a symbolic rather than true epicenter of the economic crisis, NYC experienced a shorter and shallower downturn during the Great Recession than vast swathes of the nation [15]. Given the divergence from the national pattern, this study aims to isolate some of the forces that affect women's suicide rates in the city. In keeping with the existing literature, we expect that changes in demographic, life event and economic risk factors, to be at play. We draw on 4 decades of data from multiple sources to roughly approximate the changing socioeconomic and cultural milieu of the city's women. To our knowledge, this is the first such epidemiological study of women's suicide rates in NYC.

Methodology

Analytical framework

Ecological studies of suicide typically follow Durkheim's classical view that suicide rates in a population reflect levels of social integration and social regulation [16]. Social integration refers to the extent to which individuals feel bonded to society through shared beliefs and common goals, while social regulation refers to mechanisms that regulate behavior. With respect to the former, factors that correlate with greater social integration, such as marriage and fertility, should correlate with lower levels of self-harm. With respect to the latter, Durkheim argued that changes that make social norms unstable, such as a rapidly changing socioeconomic role for women, could lead to a breakdown of values that limit suicidal behavior. A complementary explanation for the role of economic variables can be found in the work of Hamermesh and Soss [17]. They argue that suicides occur when individuals find that their expected lifetime utility (i.e., satisfaction) levels fall below their minimum threshold levels required for living. From this perspective, better economic prospects lead to fewer suicides because expected incomes and consumption levels will increase, thereby increasing expected lifetime utility.

Because others have shown that a failure to stratify populations by gender can lead to biased findings [18, 19], we focus only on the behavior of NYC women aged 15–44 to gauge the impact of time-varying societal stressors that could lead to more suicides. We specifically assess the influence of changing ethnicity, marriage, fertility, perinatal (fetal and infant) deaths, abortions, sexual violence, unemployment and per capita income levels on women's inclination to end their lives.

Data sources

We chose 1973–2014 as the study period because data are unavailable for two of the variables in other years. Specifically, suicide levels by gender in NYC became continuously available in 1973 while rapes began to be recorded under a new definition after 2014. All data reflect annual values.

The dependent variable of interest in this study is the suicide rate (per 100,000) of New York City women aged 15–44, with the analysis limited to this age cohort because suicide levels for older women were unavailable in some years. Since many of the reproductive-age pertinent covariates are highly incident in this cohort, and it has experienced the same general trend in suicides as women who are older, this data limitation should not be overly restrictive in the final analysis [7].

The suicide rate was calculated by dividing the number of suicides drawn from the New York City Bureau of Vital Statistics [20] by the corresponding United States Bureau of Census 15–44 female cohort population size. For the 2000–2014

period, annual Census Bureau values were obtained from the Area Health Resources File [21]. Because annual data were unavailable prior to 2000, a cubic spline was used to interpolate annual population values for the 1973–1999 period using decennial 1970, 1980 and 1990 Census Bureau population values reported in NYC Vital Statistics volumes.

To compensate for factors that could influence social integration and social regulation, annual measures of eight socio-demographic, life event and economic risk variables were assembled for the 1973–2014 period. They include a measure of the city's ethnic mix (percent of its female population that is white), its marriage and fertility rates, its abortion and perinatal death rates, a measure of sexual violence (forcible rapes reported 10,000 women) and the city's unemployment rate and its per capita income.

To gauge the influence of religious and cultural change that may be coded into race/ethnicity in complex ways, the percentage of women who were classified as White was included as an explanatory variable. This demographic has been associated with consistently higher suicide rates among women [1]. In addition, changes in a population's ethnic makeup have also been shown to increase suicidal behavior by increasing community fragmentation [22, 23]. Like the population data discussed above, annual Census Bureau ethnic mix data was obtained either from the Area Health Resource File (2000–2014) or interpolated from decennial Census values recorded in NYC Vital Statistics (1973–1999).

To assess changes in social norms and family formation over the time span under study, we consider both marriage and fertility rates as variables of interest. Existing studies have found that marriage is an important dimension influencing social integration and regulation, with a demonstrable salutary effect on suicide among men [18, 19]. In contrast, how suicidal behavior responds to changing fertility levels is not clear a priori as existing studies offer mixed evidence; some find that female suicide rates fall with higher fertility rates [24, 25], while others find the opposite to be true [26, 27] and yet others find that higher fertility rates correlate with lower suicide rates in men but not in women [28].

To measure the possible influence of changing levels of family formation, our analysis includes the number of new marriages per 1000 NYC residents calculated from NYC Vital Statistics source data. A general fertility rate measuring the number of live births per 1000 women of broad reproductive age (namely 15–39) was also calculated using NYC Vital Statistics data. Although data limitations precluded calculating a fertility rate for this study's age cohort (15–44), their rate is likely to closely mirror that employed by this study because 15–39 year olds comprise nearly all (> 95%) of total pregnancies in NYC (source: NYC Vital Statistics).

Two additional variables we consider that may be pertinent for women of broad reproductive age are abortion rates and perinatal death rates, also calculated from the NYC Vital Statistics

data. As with the general fertility rate, the annual measurements were divided by the size of female population aged 15–44 to get rates per 1000. While perinatal deaths are associated with negative mental health outcomes [29, 30], abortion's impact on mental health is unclear. Past studies have reported decidedly mixed findings, largely reflecting differences in method and sample. However, two comprehensive reviews of the research both conclude that the most rigorous studies find little difference in mental health risks between women who terminate and those who deliver an unplanned pregnancy [31, 32].

Among other variables that may approximate idiosyncratic life event forces, sexual violence has well-documented negative effects on victims' mental health, with rape as one of its most traumatic forms; large cross-country surveys leave little doubt that suicide ideation and attempts among women correlate strongly with the incidence of rape [33, 34]. While issues of under-reporting can make rape statistics an unreliable measure of its true prevalence in the population, changes in this statistic should broadly correlate with changes in the actual number of rapes over time. However, if reporting of sexual crimes becomes more socially acceptable and common over time, we may see an upward trend in this statistic without a true increase in crime. Indeed, research at the national level suggests the reporting of sexual crimes did increase over the 1973–2005 period [35]. However, a subsequent study finds that this was far less the case in NYC than in other metropolitan areas [36]. In fact, this statistic decreased in NYC for most of this period (see Fig. 7) and we include this measure in our list of explanatory variables. The data on the annual number of forcible rapes occurring in NYC were drawn from US Department of Justice Uniform Crime Reports sources [37, 38]. Annual rape incidence per 10,000 women was then calculated using Bureau of Census NYC women population values recorded in the AHRF or NYC Vital Statistics sources described above.

Finally, two measures assessing economic risk, the unemployment rate and real per capita income, are included as explainers. Unemployment not only leads to lowered incomes and family financial pressures but also increases social stigmatization whenever employment is considered a social norm. While studies have found that women's suicides increase with higher unemployment [12, 27, 39], the consensus remains that the link is much stronger and often concentrated in working-age males [11, 13, 40]. The second economic variable, per capita income, has typically been a less reliable macroeconomic aggregate in explaining suicide rates. Some studies have found that rising personal income leads to fewer suicide deaths [25, 41, 42] while others have identified no significant relationship [43]. For the former, annual NYC unemployment rates compiled by the US Bureau of Labor Statistics Local Area Unemployment Statistics (LAUS) program were obtained from the NY State Department of Labor [44]. For the latter, a real inflation adjusted per capita income measure for NYC residents was derived by dividing US Bureau of Economic Analysis nominal per capita income values [45] by NY metro consumer price index values reported by the US Department of Labor [46].

Table 1 Tests for non stationarity of time series aggregates

Augmented Dickey Fuller (ADF) tests for unit roots

Variable	ADF for level	ADF for change	Test result
Suicides	−2.16	−8.97**	$I(1)$
White (%)	1.93	−7.11**	$I(1)$
Marriages	−2.39	−6.09**	$I(1)$
Live births	−2.41	−3.99**	$I(1)$
Perinatal deaths	−0.71	−8.83**	$I(1)$
Abortions	0.10	−5.20**	$I(1)$
Forcible rapes	−0.18	−5.58**	$I(1)$
Unemployed	−4.24**	−5.39**	$I(0)$

*Indicates significant at the 5% level

**At the 1% level

Time series estimation method

To identify which, if any, of the demographic, life event and economic risk factors influence the propensity for terminating one's life, a multivariate regression format was utilized, with all of the series transformed to logs. Because nearly all of the variables in this study exhibit long periods of drift either upward or downward, we first tested whether they were nonstationary using the Augmented Dickey Fuller (ADF) test. Nonstationary variables have means that vary over time and if analyzed by ordinary least squares (OLS) regression methods would likely generate spurious regression results. The ADF tests (see Table 1) demonstrate that all of the variables, save unemployment, were nonstationary in levels but stationary in differences, i.e., were $I(1)$ variables. The sole exception, the unemployment rate, was a stationary in levels $I(0)$ variable. Since the dependent variable was $I(1)$ and the explainers consist of both $I(1)$ and $I(0)$ series, the autoregressive distributed lag (ARDL) approach to cointegration was employed to analyze the relation between deaths caused by self-inflicted harm and the explanatory variables [47]. The following describes the unrestricted error correction ARDL model estimated for the women's suicide rate:

$$\begin{aligned}
\text{Suicides}_t = {} & \beta_0 + \theta_1 \text{Whites}_t + \theta_2 \text{Marriages}_t + \theta_3 \text{LiveBirths}_t \\
& + \theta_4 \text{PerinatalDeaths}_t + \theta_5 \text{Abortions}_t + \theta_6 \text{Rapes}_t \\
& + \theta_7 \text{RealPCIncome}_t + \theta_8 \text{Unemployed}_t \\
& + \sum \lambda_t \Delta \text{Suicides}_t + \sum \delta_t \Delta \text{Whites}_t \\
& + \sum \Phi_t \Delta \text{Marriages}_t + \sum \gamma_t \Delta \text{LiveBirths}_t \\
& + \sum \eta_t \Delta \text{PerinatalDeaths}_t + \sum o_t \Delta \text{Abortions}_t \\
& + \sum \pi_1 \Delta \text{Rapes}_t + \sum \psi_t \Delta \text{RealPCIncome}_t \\
& + \sum \kappa_t \Delta \text{Unemployed}_t + \varepsilon_t.
\end{aligned} \quad (1)$$

In estimating the ARDL model, Schwartz and Akaike information criteria were utilized to identify the most parsimonious lag structure that generated error terms that were well-behaved (as confirmed by Lagrange multiplier, ARCH and Jarque–Bera tests). Once the lag structure was determined, a Bounds test of cointegration was conducted where the null hypothesis was H_0: all Θ_s in the above model are zeros. The Bounds test demonstrated that the suicide level for NYC women had a long run relationship with at least some of the explanatory variables (sample $F = 4.65 > $ critical $F = 3.9$ at the 1% significance level).

Given the finding that the propensity to commit suicide and the explanatory factors were cointegrated, the ARDL model above was rearranged into a familiar error correction model that describes the long run relations between suicide and the explainers and how short run changes lead to adjustments around the equilibrium. The long run relationship is given by:

$$\begin{aligned}
\text{Suicides}_t = {} & \alpha_0 + \alpha_1 \text{Whites}_t + \alpha_2 \text{Marriages}_t + \alpha_3 \text{LiveBirths}_t \\
& + \alpha_4 \text{PerinatalDeaths}_t + \alpha_5 \text{Abortions}_t + \alpha_6 \text{Rapes}_t \\
& + \alpha_7 \text{RealPCIncome}_t + \alpha_8 \text{Unemployed}_t + v_t,
\end{aligned} \quad (2)$$

while the short run error correction model (ECM) is:

$$\begin{aligned}
\Delta \text{Suicides}_t = {} & \beta_0 + \sum \lambda_t \Delta \text{Suicides}_t + \sum \delta_t \Delta \text{Whites}_t \\
& + \sum \varphi_t \Delta \text{Marriages}_t + \sum \gamma_t \Delta \text{LiveBirths}_t \\
& + \sum \eta_t \Delta \text{PerinatalDeaths}_t + \sum o_t \Delta \text{Abortions}_t \\
& + \sum \pi_1 \Delta \text{Rapes}_t + \sum \psi_t \Delta \text{RealPCIncome}_t \\
& + \sum \kappa_t \Delta \text{Unemployed}_t + \varpi \text{ECT}_{t-1} + \varepsilon_t,
\end{aligned} \quad (3)$$

The ECT_{t-1} is the lagged error correction term derived from the estimated error terms (v_t) for the long run relationship Eq. (2), while ϖ shows the speed of adjustment back to equilibrium when short run disturbances occur.

Results and discussion

Time series patterns in the data

Figures 1, 2, 3, 4, 5, 6, 7, 8 and 9 present the time series plots for the suicide rate for NYC women and the demographic, life event and economic variables for the 1973–2014 period. During that time, deaths by suicide fell dramatically (−67%) from 1973 to 2000 before starting a slow upward climb. The ethnicity and perinatal death measures exhibited somewhat similar time trends, both falling markedly prior to 2000, but continuing to decline afterward at a much smaller pace. The time patterns of the marriage, fertility and abortion levels did not, however, correspond closely to the level of suicides, but they did demonstrate somewhat similar behaviors
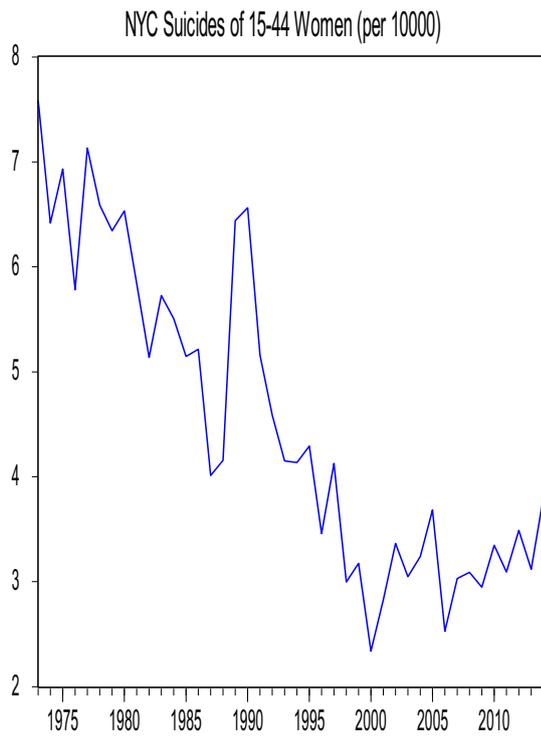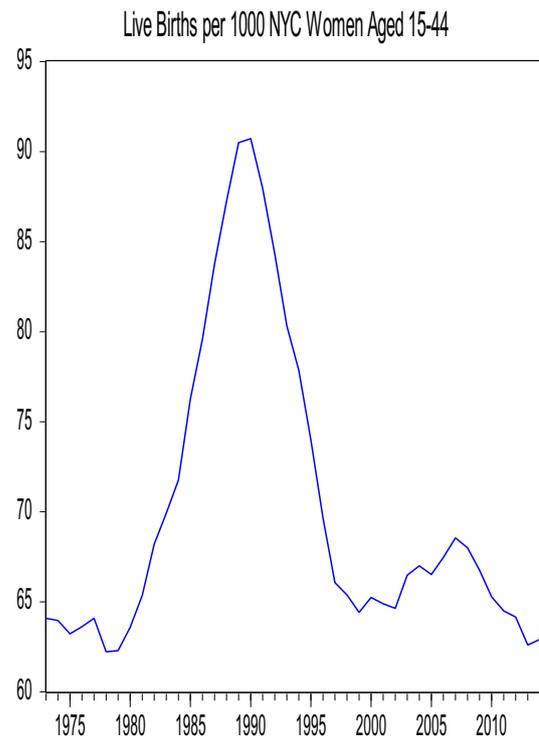
Fig. 1 Suicide rate
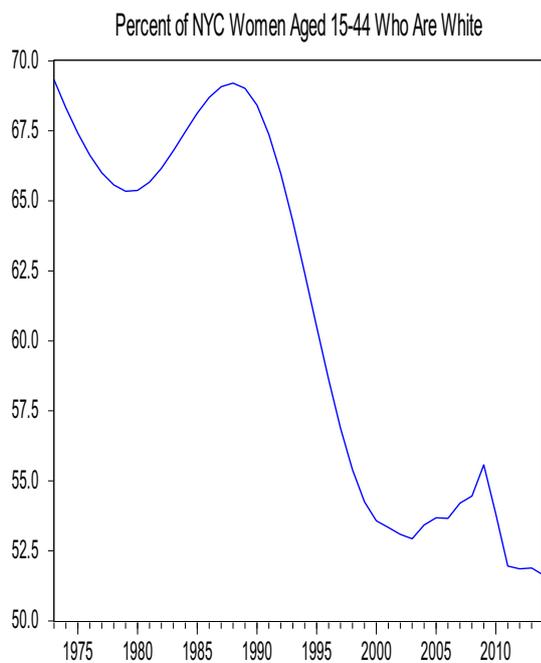

Fig. 2 Percent white

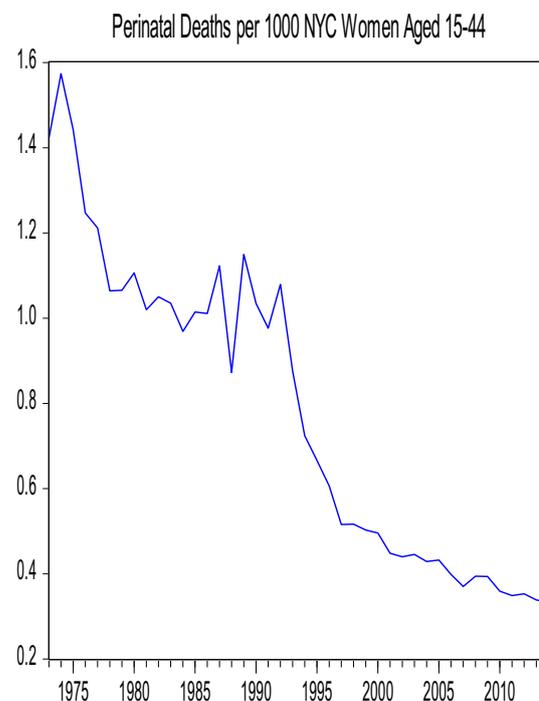**Fig. 3** General fertility rate

Fig. 4 Perinatal deaths

to each other. Marriages peaked in 1986, and then began a long decline of some 15 years before starting another more modest increase. Fertility spiked between 1980 and 1990,

increasing 50%, before returning in 1999 to levels that prevailed earlier. Abortions slowly increased from 1973 to 1992
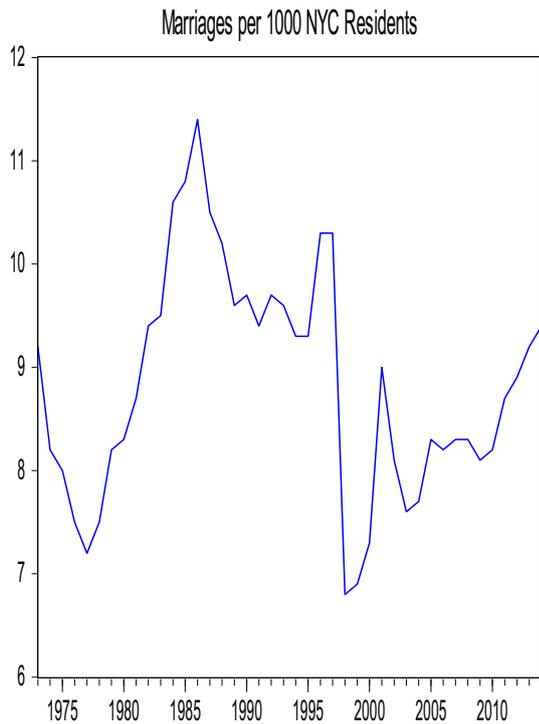
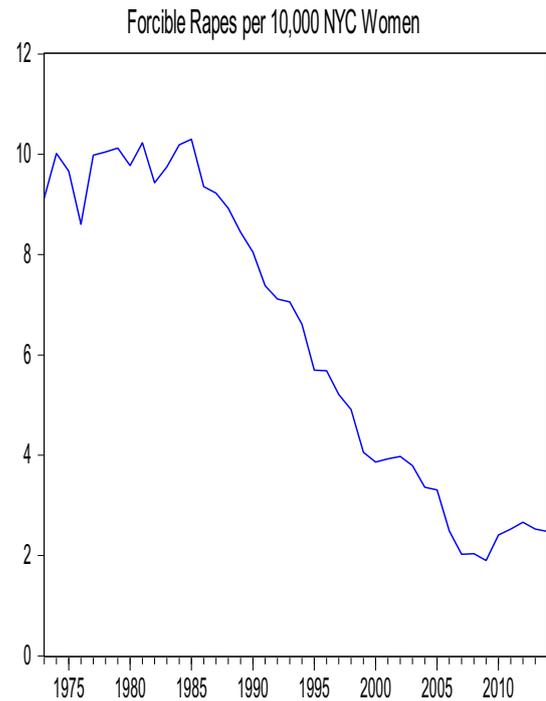**Marriages per 1000 NYC Residents**

Fig. 5 Marriage rate

Abortions per 1000 NYC Women Aged 15-44

Fig. 6 Abortion rate

Forcible Rapes per 10,000 NYC Women
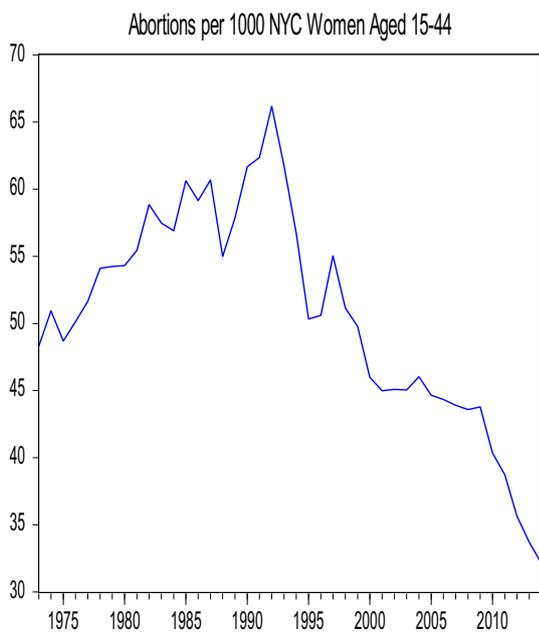
Fig. 7 Reported rapes
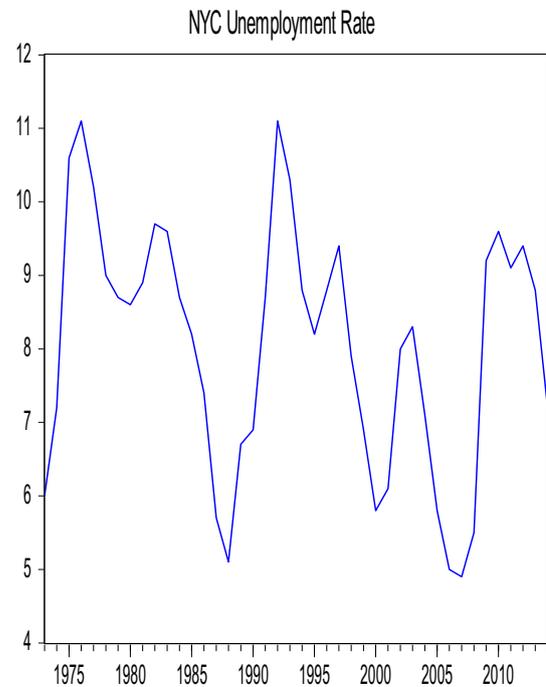
NYC Unemployment Rate

Fig. 8 Unemployment rate

before starting a rather large decline that continued through 2014, while perinatal deaths show a general trend downwards, falling till the late 1970s, fluctuating for most of the 1980s, and falling quite unambiguously after, first at faster

and then at slower rates. The number of forcible rapes held steady between 1973 until 1985 and then declined precipitously (−80%) until 2009 before starting to increase again.
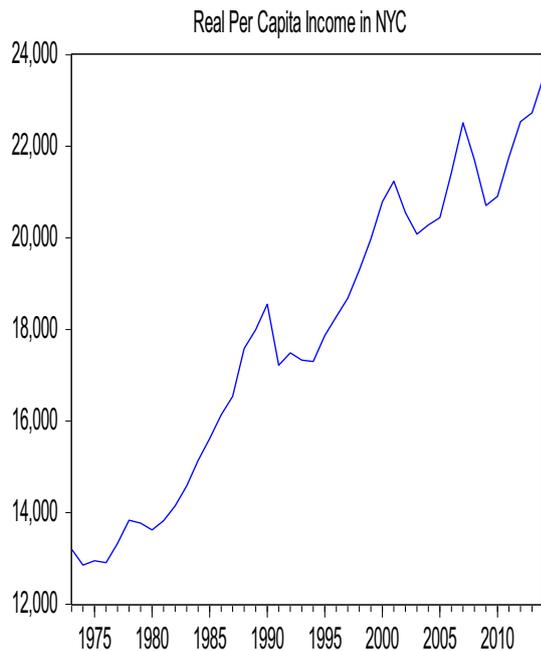
Real Per Capita Income in NYC

Fig. 9 Per capita income

The last two figures (Figs. 8, 9) show that from 1973 onward, real per capital income for NYC residents increased fairly steadily, interrupted by several periods of excess unemployment. Peaks in unemployment seemed to correspond to spikes in suicide, suggesting that labor market conditions might be an important determinant of women's self-harm behavior.

Estimation results

Table 2 contains the estimated short and long run effects of the error correction model, as well as diagnostic test results. The long run results demonstrate that the temporal pattern of suicidal behavior in NYC women can be explained by demographic, life event and economic risk factor changes. The suicide rate has been particularly sensitive to changes in the ethnic makeup of the city and the abortion rate, while changing levels of violence towards women and economic hardship have had smaller impacts. None of the other explanatory variables evidenced significant effects.

The long run elasticity of suicide with respect to changes in the white population was nearly 3, indicating that deaths from self-harm decreased by 30% points for every 10% point increase in the minority population. With respect to abortion, the unit elasticity value shows that for every 10% point increase in pregnancies terminated, suicides declined by a comparable magnitude. More modest, yet sizable effects were found for forcible rape and unemployment. Their elasticities

indicate that the suicide rate would increase by 2.5% for every 10% increase in either factor.

The coefficient (− 0.954) on the error correction term was highly significant, confirming the earlier finding of the Bounds test that there was a long run relationship between women's suicide and at least some of the explainers. The magnitude also demonstrates that it takes just a short time (namely just 1 year) for the suicide level to return to its long run relative level if short-term disturbances push it out of equilibrium. The short run effect results also indicate that the only significant factor that would cause such a disturbance was a change in the unemployment rate in the city.

The main limitations of this study stem from issues of data availability. One such limitation arises from the lack of annual Census data on NYC's population, and its age, gender and ethnic makeup, for the years prior to 2000. To calculate population-adjusted rates of suicide, fertility, infant deaths, abortion and marriage formation in those years, this study interpolates the missing annual population values using decennial Census data. Employing an adjustment that utilizes smoothed interpolated annual population values likely introduces some measurement error but not bias into the study's findings since the former's year to year changes are uncorrelated with the temporal patterns of the series being adjusted. Another limitation, common to many other population studies of mental health disorders, arises from the lack of information on other variables that might have also influenced suicidal behavior in NYC women. For example, a lack of data on the increasing use of antidepressants in the cohort of interest forces us to leave out this important aspect of the problem in the analysis. Similarly, whether the AIDS epidemic, felt acutely in New York City till the mid-1990s, affected suicide rates and perhaps some of the explainers in the model is a question we are also unable to explore. However, focusing on New York City's women, given the recent divergence in their suicide rates from men, allows us to consider a more complete list of explainers than would be available at higher levels of aggregation.

Conclusions

Because changing economic conditions in New York City (NYC) fail to correlate with the "deaths of despair" explanation, this analysis sought to identify what factors explained the historical pattern of suicide in younger (15–44 years) women. We look at possible contributing factors that may collectively approximate the changing environment for women in the city and act as stressors on this population. Drawing on data from multiple sources spanning more than 4 decades, we consider city level aggregates such as its marriage, fertility, and abortion rates, sexual violence against women as measured by reported rapes, as well as economic variables that map

Table 2 Error correction model results for the time series behavior of suicides in NYC women

Explainer	Coefficient	t ratio
Short run effects: dependent variable = Δsuicides$_t$		
Whitest (0)	2.148	1.018
Marriages$_t$ (0)	0.053	0.189
Live births$_t$ (0)	−0.580	−1.219
Perinatal deaths$_t$ (0)	0.182	0.676
Abortions$_t$ (0–1)	0.256	0.417
Forcible rapes$_t$ (0)	0.370	1.576
Real PC income$_t$ (0)	−0.043	−0.043
Unemployed$_t$ (0)	0.270*	1.860
Error correction term	−0.954**	−4.948
Long run effects: dependent variable = suicides$_t$		
Whitest	2.965*	1.888
Marriages$_t$	−0.325	−1.179
Live births$_t$	−0.0356	−0.41
Perinatal deaths$_t$	−0.106	−0.349
Abortions$_t$	−1.004**	−2.869
Forcible rapes$_t$	0.262*	1.75
Real PC income$_t$	0.155	0.17
Unemployed$_t$	0.249*	2.204
Constant	−8.435	−0.742
Diagnostics	Test statistic	p value
Bounds F	4.65**	<0.01
Serial correlation LM	3.84	0.15
BPG heteroskedasticity	3.4	0.97
Jarque–Bera normality	0.59	0.74

Short run effects: dependent variable = Δsuicides$_t$: *indicates significant at the 5% level and **at the 1% level. The reported short run coefficients are the sum of current and past effects of each explainer, with the number of current (0) and past (1 or more) lags in parentheses

Long run effects: dependent variable = suicides$_t$: *indicates significant at the 5% level and **at the 1% level

the business cycle over time, such as per capita income and the unemployment rate. Using a flexible lag structure to estimate the temporal relationships, we do find evidence of a long run "equilibrium" relationship between suicide rates and at least some of explainers considered.

Unsurprisingly, the changing racial makeup had the strongest effect on the city's suicide rate. As the White share, i.e., the demographic with the highest rate nationwide, has fallen, thus has the overall suicide rate for NYC women. The second most influential factor explaining changes in suicidal behavior was the abortion level, i.e., periods of greater induced terminations led to lower levels of self-harm. While micro studies find little evidence of differential mental health outcomes between women who terminate and carry unplanned pregnancies, our study cannot be directly compared to those without committing the ecological fallacy of projecting aggregate relationships onto individual behavior. Whether higher abortion rates act as a proxy for higher opportunity costs of bearing children, perhaps due to better economic opportunities for women

in the workplace (which may contribute to lower suicide rates), is difficult to assess given the level of aggregation in the data. Nevertheless, the 1970 legalization certainly reduced the stigma associated with abortion, which could have resulted in fewer mental health problems resulting from unwanted pregnancies being carried to term.

Interestingly, variables traditionally used to measure the degree of social integration, i.e., marriage and fertility rates in society, do not appear to have any association with the suicide rates among NYC women, a finding that concurs with previous cross-country suicide research [28]. However, worsening economic outcomes, specifically a higher unemployment rate, is associated with higher suicide rates in this demographic. This positive association between unemployment and suicide rates found in many studies to be concentrated in men appears valid for women as well, which is unsurprising as women continually become more integrated into the workforce and bear greater economic responsibilities.

Finally, sexual violence against women, as measured by the number of reported rapes in NYC, is positively associated with the suicide rate in women, a sobering but unsurprising finding, given the large number of existing micro studies that find long-term negative mental health outcomes in survivors of rape.

In conclusion, this study finds that suicides among young women in NYC are likely related to an interplay of demographic, socioeconomic and gender-related forces, which opens up more lines of enquiry that merit further exploration. The first could zoom in on county-level data for NYC (only available for more recent years) to see if meaningful inter-county differentials exist, and ask what risk factors a panel data analysis finds to be most strongly associated with women's suicides. The second could take a broader spatial perspective and ask whether other large and dynamic city centers in the US experienced a similar gender differential in their recent suicide trends; if so, if there is a rural–urban gap not simply in the total suicide rate (generally known to be higher in the former), but in how the gender differential in suicides has evolved over time.

Compliance with ethical standards

References

1. Curtin SC, Warner M, Hedegaard H (2016) Increase in suicide in the United States, 1999–2014. NCHS data brief, no 241. National Center for Health Statistics. https://www.cdc.gov/nchs/products/databriefs/db241.htm. Accessed 12 Apr 2018

2. OECD (2016) Health at a glance: Europe 2016, state of health in the EU cycle. https://doi.org/10.1787/health_glance_eur-2016-12-en. Accessed 12 Apr 2018

3. The Economist (2016) The saddest trend: suicide rates are rising in America, and in other rich countries. Economist. 13 Apr 2016. https://www.economist.com/news/united-states/21697852-suicide-rates-are-rising-america-and-other-rich-countries-saddest-trend. Accessed April 12 2018

4. American Foundation for Suicide Prevention: Suicide statistics. https://afsp.org/about-suicide/suicide-statistics/. Accessed 12 Apr 2018

5. New York City Department of Health and Mental Hygiene (2016) Suicides in New York City, 2000 to 2014. EPI data brief no. 75. https://www1.nyc.gov/assets/doh/downloads/pdf/epi/databrief75.pdf. Accessed 12 Apr 2018

6. Ramchand R, Becker A (2014) Suicide rates in california: trends and implications for prevention and early intervention programs. RAND Corporation, Santa Monica. https://www.rand.org/pubs/research_briefs/RB9737.html. Accessed 1 June 2018

7. Illinois Department of Public Health, Division of Vital Records, Death Certificate Data Files (2015) https://www.chicagohealthatlas.org/indicators/suicide. Accessed 1 June 2018

8. Case A, Deaton A (2017) Mortality and morbidity in the 21st century. Brookings papers on economic activity, Spring 2017, pp 397–476

9. Hempstead KA, Phillips JA (2015) Rising suicide among adults aged 40–64 years: the role of job and financial circumstances. Am J Prev Med 48:491–500

10. Rachiotis G, Stuckler D, McKee M, Hadjichristodoulou C (2015) What has happened to suicides during the Greek economic crisis? Findings from an ecological study of suicides and their determinants (2003–2012). BMJ Open. https://doi.org/10.1136/bmjopen-2014-007295

11. Norström T, Grönqvist H (2015) The great recession, unemployment and suicide. J Epidemiol Commun Health 69:110–116

12. Phillips JA, Colleen NN (2014) Suicide and the great recession of 2007–2009: the role of economic factors in the 50 US states. Soc Sci Med 16:22–31

13. Reeves A, McKee M, Stuckler D (2014) Economic suicides in the great recession in Europe and North America. Br J Psychiatry 205:246–247

14. Coope C, Gunnell D, Hollingworth W, Hawton K, Kapur N, Fearn V, Wells C, Metcalfe C (2014) Suicide and the 2008 economic recession: who is most at risk? Trends in suicide rates in England and Wales 2001–2011. Soc Sci Med 117:76–85

15. NYC Comptroller's Office Report (2017) New York City's labor market: evidence from the recent expansion. https://comptroller.nyc.gov/reports/new-york-citys-labor-market-evidence-from-the-recent-expansion/. Accessed 1 June 2018

16. Durkheim E (1897) Suicide: a study in sociology (trans: JA Spaulding, G. Simpson, 1951 ed.). The Free Press, New York

17. Hamermesh DS, Soss NM (1974) An economic theory of suicide. J Polit Econ 82:83–98

18. Kposowa AJ (2000) Marital status and suicide in the national longitudinal mortality. J Epidemiol Commun Health 54:254–261

19. Denney JT, Rogers RG, Krueger PM, Wadsworth T (2009) Adult suicide mortality in the United States: marital status, family size, socioeconomic status, and differences by sex. Soc Sci Q 90:1167–1185

20. New York City Department of Health Office of Vital Records (NYCDOHOVR). Summary of vital statistics, annual volumes from 1973 to 2014. http://www1.nyc.gov/site/doh/data/vital-statistics/vital-statistics-summary.page. Accessed 1 May 2017

21. Health Resources and Service Administration (HRSA) Data Warehouse Area Health Resources File (AHRF) county level data set. https://datawarehouse.hrsa.gov/data/datadownload.aspx#MainContent_ctl00_gvDD_lbl_dd_topic_ttl_0. Accessed 15 Dec 2016

22. Kposowa AJ, McElvain JP, Breault KD (2008) Immigration and suicide: the role of marital status, duration of residence, and social integration. Arch Suicide Res 12:82–92

23. Stack S (2000) Suicide: a 15-year review of the sociological literature. Part II: modernization and social integration perspectives. Suicide Life Threat Behav 30:163–176

24. Bhandarkar R, Shah A (2008) Association of general population suicide rates with fertility rates: a test of fertility as a measure of social integration. Psychol Rep 103:812–818

25. Neumayer E (2003) Are socioeconomic factors valid determinants of suicide? Controlling for national cultures of suicide with fixed-effects estimation. Cross Cult Res 37:307–329

26. Classen TJ, Dunn RA (2012) The effect of job loss and unemployment duration on suicide risk in the United States: a new look using mass-layoffs and unemployment duration. Health Econ 21:338–350

27. Yamamura E (2009) The different impacts of socio-economic factors on suicide between males and females. Appl Econ Lett 17:1009–1012

28. Milner A, McClure R, De Leo D (2012) Socio-economic determinants of suicide: an ecological analysis of 35 countries. Soc Psychiatry Psychiatr Epidemiol 47:19–27

29. Surkan PJ, Sakyi K, Strobino DM, Mehra S, Labrique A, Ali H, Ullah B, Wu L, Klemm R, Rashid M, West KP, Christian P (2016) Depressive symptoms in mothers following peri-natal and early infant loss in rural Bangladesh: a population-based study. Ann Epidemiol 26:467–473

30. Gold K, Johnson TRB (2014) Mothers at risk maternal mental health outcomes after perinatal death. Obstet Gynecol. https://doi.org/10.1097/AOG.0000000000000204

31. American Psychological Association (2008) Report of the task force on mental health and abortion. http://www.apa.org/pi/wpo/mental-health-abortion-report.pdf. Accessed 16 Apr 2018

32. Charles VE, Polis CB, Sridhara SK, Blum RW (2008) Abortion and long-term mental health outcomes: a systematic review of the evidence. Contraception 78:436–450

33. Campbell R, Wasco SM (2005) Understanding rape and sexual assault: 20 years of progress and future directions. J Interpers Violence 20:127–131

34. World Health Organization Department of Reproductive Health and Research, London School of Hygiene and Tropical Medicine, South African Medical Research Council (2013) WHO global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence. http://apps.who.int/iris/bitstream/handle/10665/85239/9789241564625_eng.pdf?sequence=1. Accessed 14 Apr 2018

35. Baumer EP, Lauritsen JL (2010) Reporting crime to the police, 1973–2005: a multivariate analysis of long-term trends in the National Crime Survey (NCS) and National Crime Victimization Survey (NCVS). Criminology 48:131–185

36. Xie M (2012) Area differences and time trends in crime reporting: comparing New York with other metropolitan areas. Justice Q 31:43–73

37. Federal Bureau of Investigation, US Department of Justice (FBI-USDOJ). Uniform crime reports for the United States, "Table: number of offenses known to the police, year, cities and towns 25,000 and over in population", Washington, DC, annual volumes from 1973 through 1984

38. US Department of Justice, Bureau of Justice Statistics (USDOJBJS). Uniform crime reports, crime local level single agency reported crime. http://www.bjs.gov/ucrdata/Search/Crime/Local/JurisbyJurisStepTwo.cfm. Accessed 1 May 2017

39. Snipes M, Cunha TM, Hemley DD (2011) An empirical investigation into the relationship between changes in the business cycle and the incidence of suicide. Int J Soc Econ 38:477–491

40. Modrek S, Stuckler D, McKee M, Cullen MR, Basu S (2013) A review of health consequences of recessions internationally and a synthesis of the US response during the great recession. Public Health Rev 35:1–33

41. Innamorati M, Tamburello A, Lester D, Amore M, Girardi P, Tatarelli R, Pompili M (2010) Inequalities in suicide rates in the European Union's elderly: trends and impact of macro-socioeconomic factors between 1980 and 2006. Can J Psychiatry 55:229–238

42. Nandi A, Prescott MR, Cerdá M, Vlahov D, Tardiff KJ, Galea S (2018) Economic conditions and suicide rates in New York City. Am J Epidemiol 175:527–535

43. Ceccherini-Nelli A, Priebe S (2011) Economic factors and suicide rates: associations over time in four countries. Soc Psychiatry Psychiatr Epidemiol 46:975–982

44. New York State Department of Labor Local Area Unemployment Statistics Program (NYSDOLLAUSP). https://labor.ny.gov/stats/laus.asp. Accessed 4 Sept 2016

45. Bureau of Economic Analysis Interactive Data (BEAID). GDP & personal income regional data. https://www.bea.gov/itable/iTable.cfm?ReqID=70&step=1#reqid=70&step=26&isuri=1&7022=20&7023=7&7024=non-industry&7025=4&7001=720&7029=20&7090=70&7031=36000. Accessed 1 Mar 2017

46. US Department of Labor Bureau of Labor Statistics (USDOL-BLS). Database, tables and calculators by subject. https://data.bls.gov/pdq/SurveyOutputServlet. Accessed 4 Mar 2017

47. Pesaran MH, Shin Y, Smith RJ (2004) Bounds testing approaches to the analysis of long-run relationships. Cambridge working papers in economics. https://doi.org/10.17863/CAM.5093