


Is Economic Policy Uncertainty Related to Suicide Rates? Evidence from the United States

Nikolaos Antonakakis^{1,2}  · Rangan Gupta³

Accepted: 6 June 2016 / Published online: 20 June 2016
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Abstract While it has long been recognised that periods of economic uncertainty, characterised by increased unemployment and lower economic activity, are associated with increased suicide rates, no study has examined the impact of policy-related economic uncertainty on suicide mortality. The aim of this study is to examine the relationship between economic policy uncertainty and suicide mortality in the United States over the period 1950–2013, while controlling for several other socioeconomic determinants of suicide mortality, as well as age- and gender-variations. The results of the analysis reveal that increased economic policy uncertainty is associated with increased suicide mortality of the youngest and the oldest segments of the male population in the United States, while the female population across all ages is found to be resilient to changes in economic policy uncertainty.

Keywords United States · Economic policy uncertainty · Suicide

JEL Classification E60 I31 · J11 · C22

✉ Nikolaos Antonakakis
nikolaos.antonakakis@port.ac.uk; nikolaos.antonakakis@webster.ac.at

Rangan Gupta
rangan.gupta@up.ac.za

¹ Economics and Finance Subject Group, Portsmouth Business School, University of Portsmouth, Portland Street, Portsmouth PO1 3DE, UK

² Department of Business and Management, Webster Vienna Private University, Praterstrasse 23, 1020 Vienna, Austria

³ Department of Economics, Faculty of Economic and Management Sciences, University of Pretoria, Pretoria 0002, South Africa

1 Introduction

It has long been recognised that periods of economic uncertainty are associated with rises in suicide (Durkheim 1897; Morselli 1882; Swinscow 1951). Durkheim hypothesised that key societal forces such as social integration can be disrupted by factors related to economic downturns which consequently have an impact on suicide rates. While a large amount of studies has examined the significance of such economic factors, such as unemployment (see, e.g. Morrell et al. 1993; Platt et al. 1992; Inoue et al. 2007; Noh 2009; Chang et al. 2010; Kuroki 2010; Lundin et al. 2012; Garcy and Vger 2012; Pellegrini and Rodriguez-Monguio 2013; Nordt et al. 2015; Webb and Kapur 2015; Fountoulakis et al. 2015; Dos Santos 2015; Bonamore et al. 2015; Hsu et al. 2015; Fountoulakis et al. 2015; Goldman-Mellor 2016), income and business cycles (see, e.g. Wasserman 1984; Ruhm 2000; Miller et al. 2009; Gonzalez and Quast 2010; Stuckler et al. 2011; Suhrcke and Stuckler 2012) and fiscal austerity (Antonakakis and Collins 2014, 2015; Branas et al. 2015), among others¹, no study, according to our knowledge, has explored the impact of policy-related economic uncertainty per se on suicide mortality.

In this study, we fill in this gap in the literature by examining the impact of economic policy uncertainty on suicide mortality in the United States, the latter being an important indicator of a nation's overall life-satisfaction and well being, based on a recently developed measure of economic policy uncertainty by Baker et al. (2015). As increased economic policy uncertainty can lead to adverse domestic macroeconomic circumstances, such as intensifying recessions and weakening recoveries (Baker et al. 2015), depressing investments (Kang et al. 2014; Wang et al. 2014), industrial production (Baker et al. 2015) and stock prices (Pástor and Veronasi 2012), and reducing employment (Baker et al. 2015; Ferrara and Gurin 2015), it can cause abrupt changes in the socioeconomic position of certain groups, who, becoming conscious that what has been expected can no longer be achieved, may be led to commit suicide. Indeed, when economic policy uncertainty has sizable negative side-effects, leading to greater inequalities, impoverishment and social isolation or pessimistic expectations about life satisfaction in the future, suicide rates might increase namely through an emotional process associated with increased insecurity or shame of economic failure. We thus hypothesise that changes in economic policy uncertainty are associated with suicide mortality. Moreover, we control for several other commonly used socioeconomic variables in this literature so as to account for other factor that can lead to suicide and control for potential omitted variable bias.

Our empirical results for age-standardised male and female suicide rates in the United States over the period 1950–2013, which remain robust to a battery of checks, reveal gender- and age-specificities in the impact of economic policy uncertainty on suicide mortality in the United States. In particular, increases in economic policy uncertainty are associated with significant increased male suicide rates in the youngest (15–34 age group) and the oldest (65–84 age group) segments of the population, while the female population across all ages is resilient to changes in economic policy uncertainty. For the remaining socioeconomic factors of suicide mortality, the results are very much in line with the existing literature.

The rest of this paper is organised as follows. Section 2 describes the empirical methodology and the data used. Section 3 presents the empirical results and Sect. 4 summarises and offers some concluding remarks.

¹ For a comprehensive survey of socioeconomic determinants of suicides see Chen et al. (2012).

2 Data and Methodology

2.1 Data

Annual data on suicide mortality between 1950 and 2010 are collected from the World Health Organisation (WHO) Mortality Database and extended up to 2013 based on the Center for Disease Control (CDC) online database, which contains annual observations for number of deaths by country, sex, age group and death cause.² Suicide rates are measured as the number of reported deaths per 100,000 inhabitants, where population data are obtained from the WHO Mortality and CDC online databases. The economic policy uncertainty (EPU) index, which comes from Baker et al. (2015), is a news' based index of economic policy uncertainty based on article searches of leading US newspapers for terms related to economic and policy uncertainty.³ As the EPU index is available in monthly frequency, we transform it to its annual counterpart by taking the 12-month average within each year.

Figure 1 shows the evolution of suicide rates (by gender and age group) and economic policy uncertainty (EPU) from 1950 to 2013, indicating a positive correlation between the two series. In particular, EPU, as well as suicide for certain age groups among males and females, followed an increasing trend since the 1960s till the end of the 1980s. Then a declining trend is observed in both series until 2000 which was reversed since then. Further, male suicide rates are, on average, about 4 times higher than female suicide rates, which is in line with the typical observation in the sociological literature of suicide that males are more prone to committing suicide than females (Daly and Wilson 2006; Helliwell 2007; Chang et al. 2013). US suicide rates are also, in general, lower among younger individuals, in line with the theoretical predictions of Durkheim (1897) and the subsequent literature. Age groups 45–54, 65–74 and 75–84 years show the highest suicide mortality rates, for both men and women.

Finally, to control for other socioeconomic factors on suicide rates and to minimize errors arising from unobserved effects, we collect data for fertility rates from the World Bank World Development Indicators (WDI) database; alcohol consumption from OECD Health database and divorce rates from EUROSTAT; and real gross domestic product per capita, its growth rate, and unemployment rate from the Federal Reserve Economic Database (FRED). Definitions and descriptive statistics for all these variables are included in Table 1.

2.2 Empirical Methodology

Our baseline equation to be estimated is as follows:

$$SR_{it} = \alpha + \beta_1 EPU_t + \beta_2 Unemp_t + \beta_3 Growth_t + \beta_4 GDP_t + \beta_5 Div_t + \beta_6 Alc_t + \beta_7 Fert_t + \varepsilon_t \quad (1)$$

where SR_{it} is the natural logarithm of suicide rates per 100,000 of i population, where $i =$ overall, male, female, over time t , where $t = 1950, \dots, 2013$. EPU_t is the natural logarithm of economic policy uncertainty index of Baker et al. (2015) and measures policy-related

² We have checked and confirmed that compatibility is ensured when extending the data from WHO Mortality with data from the CDC database from 2010 onwards.

³ The EPU index data, as well as their detailed description, can be obtained from http://www.policyuncertainty.com/us_historical.html.

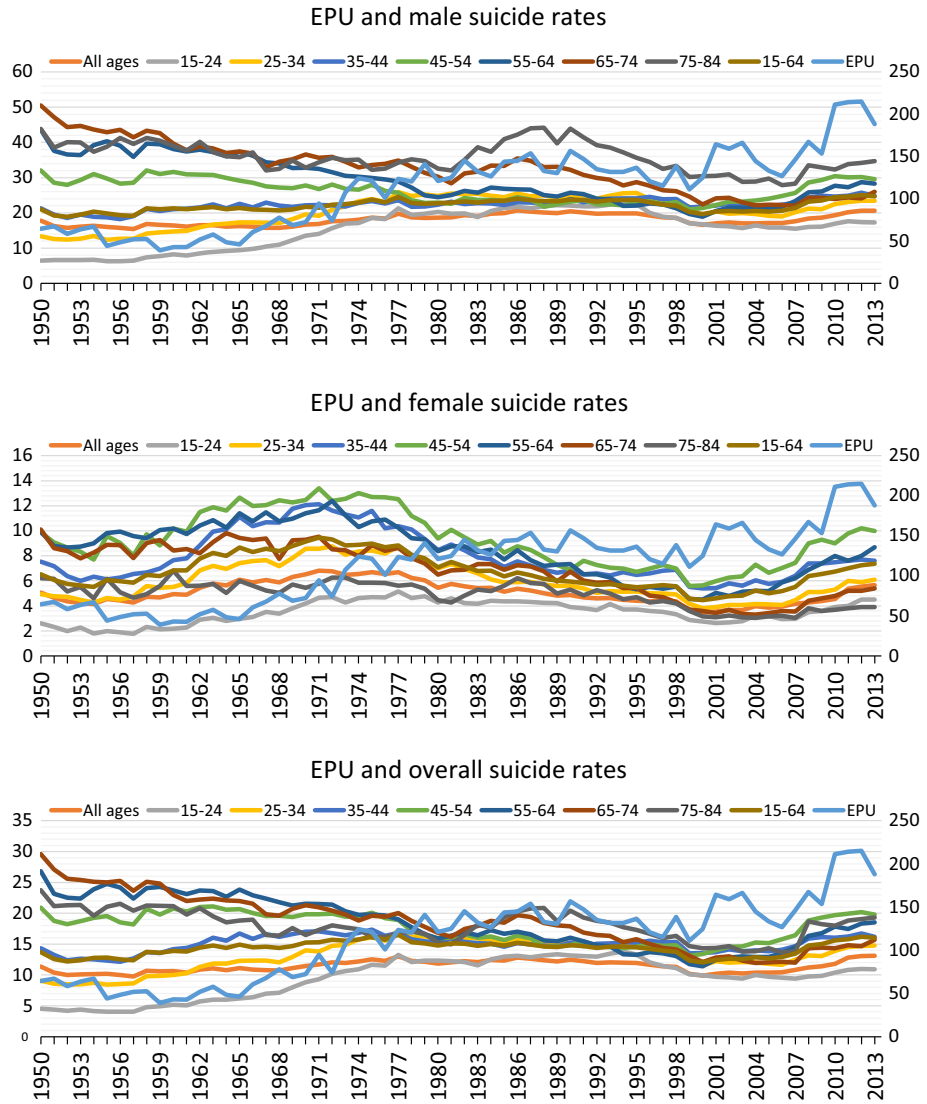


Fig. 1 Suicide rates per 100,000 residents (%) and Economic policy uncertainty in the United States, 1950–2013. *Note:* Suicide rates (left axis); EPU (right axis) *Source:* WHO, CDC and Baker et al. (2015)

economic uncertainty in the United States. $Unemp_t$ is the natural logarithm of unemployment rate; $Growth_t$ denotes per capita real GDP growth; GDP_t is the natural logarithm of real per capita GDP; $Divorce_t$ is the natural logarithm of divorce rate; Alc_t is the natural logarithm of litres of per capita alcohol consumption; $Fert_t$ is the natural logarithm of fertility rate and ε_t is the error term.

Table 1 Variable definitions and descriptive statistics

Variable	Definition	Expected signs	Availability	Obs.	Mean	Std.	Min.	Max.
Suicide rate	Overall suicide rates (deaths per 100,000 people)							
Overall	--		1950–2013	64	11.39583	0.9394409	9.760564	13.13046
All ages ^a	--		1950–2013	64	14.2983	1.168958	12.0323	16.5395
15–64	--		1950–2013	64	9.490627	3.15893	4.035516	13.78854
15–24	--		1950–2013	64	13.16315	2.481288	8.409575	17.21876
25–34	--		1950–2013	64	15.04194	1.323373	12.12502	17.35501
35–44	--		1950–2013	64	17.61268	2.413739	13.09132	21.11691
45–54	--		1950–2013	64	18.39565	4.120159	11.40695	26.81476
55–64	--		1950–2013	64	18.62576	4.324647	11.92625	29.58034
65–74	--		1950–2013	64	18.02337	2.383854	13.64309	23.71771
75–84	--		1950–2013	64				
Male	Male suicide rates (deaths per 100,000 people)							
All ages ^a	--		1950–2013	64	17.96482	1.606388	15.41786	20.70598
15–64	--		1950–2013	64	22.03055	1.593001	18.89641	25.08
15–24	--		1950–2013	64	15.36228	5.450115	6.255489	23.44746
25–34	--		1950–2013	64	20.44419	4.37183	12.36734	25.86536
35–44	--		1950–2013	64	22.32312	1.621569	18.21075	25.7
45–54	--		1950–2013	64	26.24679	3.286976	20.93823	32.05233
55–64	--		1950–2013	64	29.19588	6.457036	18.88306	43.62822
65–74	--		1950–2013	64	32.69787	7.08174	21.94847	50.47467
75–84	--		1950–2013	64	35.86978	4.193791	27.90842	44.14298

Table 1 continued

Variable	Definition	Expected signs	Availability	Obs.	Mean	Std.	Min.	Max.
Female	Female suicide rates (deaths per 100,000 people)							
All ages ^a	--		1950–2013	64	5.082131	0.9227098	3.474126	6.822641
15–64	--		1950–2013	64	6.754747	1.362217	4.450997	9.456391
15–24	--		1950–2013	64	3.50256	0.9110156	1.765607	5.158654
25–34	--		1950–2013	64	5.952274	1.443787	3.811435	8.774343
35–44	--		1950–2013	64	7.947333	1.955453	5.39207	12.13671
45–54	--		1950–2013	64	9.313271	2.181941	5.589165	13.41113
55–64	--		1950–2013	64	8.384417	2.153352	4.513304	12.38218
65–74	--		1950–2013	64	6.882939	2.041012	3.308142	10.10148
75–84	--		1950–2013	64	4.917183	1.004528	3.0378	6.81778
Total	Economic policy uncertainty index of Baker et al. (2015)	+	1950–2013	64	112.4829	46.19861	39.00932	215.1006
GDP	Per capita real GDP	--/+	1950–2013	64	7747.217	4256.94	2184	15583.3
Growth	Growth rate of per capita real GDP (%)	--/+	1951–2013	63	3.12381	2.24842	-2.8	7.8
Unemployment	Unemployment rate (% of total labor force)	+	1950–2013	64	5.860937	1.646123	2.9	9.7
Fertility	Fertility rate (births per woman)	-	1960–2013	54	2.158602	0.4822895	1.738	3.654
Alcohol	Per capita alcohol consumption (litres, age 15+)	+/-	1960–2012	53	9.05283	0.8115994	7.8	10.4
Divorce	Divorce rates (per 1000 people)	+/-	1950–2012	63	3.76127	1.051649	2.12	5.3

^a The 'all ages' suicide rate groups include also the ages below 15 and above 84

3 Estimation Results

3.1 Baseline Results

The results of model (1) for the overall, male and female population across all ages, are presented in Table 2. According to these results, increased economic policy uncertainty is significantly associated with increased suicide rates in the US only for the male population across all ages, while the female population is relatively insulated to increases in economic policy uncertainty. This result is in line with Brainerd (2001) who finds that male suicide rates are highly sensitive to the state of the macroeconomy, while female suicide rates are insensitive to the state of the macroeconomy. The fact that economic policy uncertainty may lead to worsened employment position, increased financial insecurity and greater fear of job loss can be expected to produce more psychological pressure on men than on women, given that men are on average the primary household-income providers. According to the Pew Research Center analysis of data from the US Census Bureau, 40 % of all households with children under the age of 18 include mothers who are either the sole or primary source of income for the family. While the share has risen drastically from 11% in 1960, the numbers suggest that men still remain the primary breadwinners in 60% of the US households.⁴ A similar pattern is observed for unemployment, as its coefficient is positive and statistically significant only for the male population across all ages in the US. These results again point to the direction that males are more heavily affected by the state of the macroeconomy compared to females (see e.g. Brainerd 2001; Antonakakis and Collins 2014, 2015). Annual economic growth is predicted to significantly increase male suicide rates. At first, this might seem contradictory, however, it is in line with the findings of Unnithan et al. (1994) and Lester (1996), who show that economic growth increases rates of suicide. Moreover, higher GDP (income) is significantly associated with lower suicide rates among both sexes of all ages. This result is again in line with many studies suggesting that suicide rates have a negative association with income (e.g. Chuang and Huang 1997; Brainerd 2001; Neumayer 2003; Andrés 2005; Chuang and Huang 2007; Minoiu and Andres 2008; Altinanahtar and Halicioglu 2009; Andrés and Halicioglu 2010, 2011; Okada and Samreth 2013), but are odds with others suggesting the opposite effect (e.g. Virén 1999; Jungeilges and Kirchgassner 2002).

The results related to divorce rates reveal opposing effects to suicide rates across the male and female population in the US. Specifically, the results indicate that divorce rates have suicide-increasing effects for the male population, while suicide-reducing effects for the female population, and which are in line with the existing literature (see, for instance, Kposowa 2003; Neumayer 2003; Koo and Cox 2008; Andrés and Halicioglu 2011; Antonakakis and Collins 2014; Scourfield and Evans 2015, among others). For instance, Kposowa (2003), using data from the US National Longitudinal Mortality Study (NLMS), over the period 1979–1989, find that divorced men are over eight times more likely to commit suicide than divorced women. This may seem plausible if marriage serves to over-regulate the lives of women. In that case, increasing divorce rates may be, among others, the result of financial independence for women, laws favouring women in financial settlements and women's search for identity and freedom. For example, Kposowa (2003) argues that, following a divorce settlement, custody of children is more likely to be given to the wife, as in many jurisdictions in the US there seems to be an implicit assumption that the bond between a woman and her children is stronger than that between a man and his

⁴ <http://www.pewsocialtrends.org/2013/05/29/breadwinner-moms/>.

Table 2 Economic policy uncertainty and suicide rates (per 100,000 resident), by sex in the United States, 1950–2013

	(1) Overall All	(2) Male All	(3) Female All
EPU	0.1574** (0.0679)	0.1852*** (0.0639)	0.0710 (0.1216)
Unemployment	0.0905** (0.0408)	0.0965*** (0.0353)	0.0885 (0.0751)
Growth	0.0050* (0.0027)	0.0066** (0.0026)	0.0010 (0.0062)
GDP	-0.1581*** (0.0397)	-0.0940** (0.0364)	-0.3906*** (0.0865)
Divorce	0.0255 (0.0876)	0.1974** (0.0742)	-0.4648** (0.2082)
Alcohol	-0.0863 (0.1925)	-0.2710 (0.1839)	0.5834* (0.3461)
Fertility	-0.1139 (0.1634)	0.1085 (0.1720)	-0.7788** (0.2930)
Constant	3.1804*** (0.8117)	2.9193*** (0.8219)	4.5603*** (1.4902)
Observations	53	53	53
R ²	0.694	0.785	0.846
R ² adjusted	0.647	0.752	0.822
F-statistic	15.84	38.50	23.78

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

children. This in turn leaves the husband with symptoms of betrayal, bitterness, anxiety, and depression, reduced self-esteem, and a sense of a “life not worth living”, thus increasing the risk of committing suicide. In fact, the study of Scourfield and Evans (2015) presents an overview of the sociological explanations that may be used to understand the elevated risk factor in men following divorce and separation. According to Scourfield and Evans (2015), the explanations of the aforementioned phenomenon can be summarised under the following conceptual themes: the changing nature of intimacy, men’s loss of honor, marriage as a more positive experience for men than for women, control in relationships, the increasing importance of the care of children for men, and men’s social networks. In addition, fertility rates (a proxy for social inclusion) and alcohol consumption are also significant predictors of female suicides. In particular, increases in fertility rates have significant suicide-reducing effects, while increases in alcohol consumption have significant suicide increasing effects in the female population in the US.

To what extent there are differences in the impact of economic policy uncertainty on suicides across age groups? To answer this question, we now turn, by re-estimating model (1) with disaggregated gender-specific suicide rates data for seven age groups, namely 15–24, 25–34, 35–44, 45–54, 55–64, 65–74 and 75–84 years. These results are presented in Tables 3, 4 and 5.

Table 3 Economic policy uncertainty and overall suicide rates (per 100,000 resident), by sex and age-group in the United States, 1950–2013

Age	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	15–24	25–34	35–44	45–54	55–64	65–74	75–84
EPU	0.2510** (0.1031)	0.1451** (0.0711)	-0.0044 (0.0660)	-0.0375 (0.0944)	0.0856 (0.1079)	0.1954* (0.1087)	0.3689** (0.1586)
Unemployment	-0.0357 (0.0703)	0.0489 (0.0452)	0.0386 (0.0390)	0.2043*** (0.0638)	0.1874*** (0.0663)	0.0716 (0.0590)	0.1253* (0.0736)
Growth	0.0069 (0.0046)	0.0027 (0.0037)	-0.0066* (0.0038)	-0.0084 (0.0052)	-0.0001 (0.0050)	0.0088 (0.0063)	0.0137 (0.0084)
GDP	-0.1399 (0.0839)	-0.2367*** (0.0567)	-0.1322** (0.0555)	-0.1177 (0.0959)	-0.2949*** (0.0867)	-0.4751*** (0.0798)	-0.2707*** (0.1014)
Divorce	0.7452*** (0.1609)	0.1754** (0.0828)	-0.3077*** (0.0972)	-0.7670*** (0.2032)	-0.6776*** (0.1881)	0.0018 (0.1289)	0.1229 (0.1588)
Alcohol	-0.5002 (0.4148)	-0.2313 (0.2796)	-0.0930 (0.2287)	0.4049 (0.2721)	0.7441*** (0.2715)	0.0824 (0.3101)	-0.2647 (0.3547)
Fertility	-0.2711 (0.3148)	-0.4393** (0.1951)	-0.5960*** (0.1690)	-0.6104* (0.3136)	-0.2257 (0.2871)	0.1562 (0.2664)	0.5913 (0.3664)
Constant	2.7082 (1.7132)	4.5636*** (1.1458)	4.9600*** (0.9568)	4.3452*** (1.5775)	4.1901*** (1.3790)	5.7062*** (1.3537)	3.2316* (1.6685)
Observations	53	53	53	53	53	53	53
R ²	0.937	0.862	0.541	0.806	0.897	0.892	0.467
R ² adjusted	0.928	0.841	0.470	0.776	0.881	0.876	0.384
F-statistic	104.4	37.04	6.703	49.00	76.81	43.21	8.268

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4 Economic policy uncertainty and male suicide rates (per 100,000 resident), by sex and age-group in the United States, 1950–2013

Age	(1) 1.5–24	(2) 25–34	(3) 35–44	(4) 45–54	(5) 55–64	(6) 65–74	(7) 75–84
EPU	0.2687** (0.1086)	0.1838** (0.0696)	0.0523 (0.0464)	-0.0238 (0.0812)	0.1133 (0.0921)	0.1922* (0.0966)	0.4022*** (0.1490)
Unemployment	-0.0466 (0.0706)	0.0540 (0.0436)	0.0577** (0.0248)	0.2052*** (0.0499)	0.1630*** (0.0554)	0.0094 (0.0473)	0.0342 (0.0636)
Growth	0.0067 (0.0048)	0.0052* (0.0030)	-0.0031 (0.0023)	-0.0074* (0.0039)	0.0016 (0.0043)	0.0105* (0.0053)	0.0174** (0.0074)
GDP	-0.1170 (0.0910)	-0.1727*** (0.0567)	-0.0506 (0.0363)	-0.0358 (0.0807)	-0.2873*** (0.0742)	-0.4572*** (0.0615)	-0.2761*** (0.0801)
Divorce	0.8920*** (0.1880)	0.3774*** (0.0830)	-0.1055** (0.0511)	-0.6245*** (0.1700)	-0.5772*** (0.1569)	0.1780* (0.1051)	0.4320*** (0.1492)
Alcohol	-0.6719 (0.4202)	-0.4679 (0.2801)	-0.3770** (0.1641)	0.1853 (0.2326)	0.4551* (0.2456)	-0.0619 (0.2583)	-0.1866 (0.3151)
Fertility	-0.1857 (0.3507)	-0.2769 (0.2135)	-0.2834** (0.1280)	-0.3422 (0.2764)	-0.1055 (0.2487)	0.2623 (0.2395)	0.2773 (0.3594)
Constant	3.0318 (1.8258)	4.3561*** (1.1946)	4.4235*** (0.7133)	4.0239*** (1.3704)	4.8979*** (1.2043)	6.2355*** (1.1514)	3.1677** (1.4977)
Observations	53	53	53	53	53	53	53
R ²	0.944	0.905	0.561	0.800	0.906	0.904	0.544
R ² adjusted	0.936	0.890	0.493	0.769	0.891	0.889	0.473
F-statistic	139.9	56.30	7.317	81.59	78.53	59.72	7.142

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5 Economic policy uncertainty and female suicide rates (per 100,000 resident), by sex and age-group in the United States, 1950–2013

Age	(1) 15–24	(2) 25–34	(3) 35–44	(4) 45–54	(5) 55–64	(6) 65–74	(7) 75–84
EPU	0.1693 (0.1434)	0.0268 (0.1430)	-0.1234 (0.1469)	-0.0715 (0.1413)	0.0224 (0.1532)	0.2226 (0.1719)	0.2578 (0.1595)
Unemployment	0.0886 (0.0939)	0.0827 (0.0848)	0.0241 (0.0925)	0.1976* (0.0982)	0.2074** (0.0918)	0.1362 (0.1028)	0.0388 (0.0880)
Growth	0.0058 (0.0077)	-0.0062 (0.0087)	-0.0138 (0.0092)	-0.0094 (0.0087)	-0.0024 (0.0072)	0.0087 (0.0093)	0.0133 (0.0086)
GDP	-0.2576*** (0.0925)	-0.5161*** (0.1102)	-0.3956*** (0.1305)	-0.3618*** (0.1328)	-0.3778*** (0.1122)	-0.7927*** (0.1281)	-0.6844*** (0.0961)
Divorce	-0.0887 (0.1653)	-0.5398** (0.2369)	-0.8307*** (0.2639)	-1.0878*** (0.2808)	-0.8132*** (0.2494)	-0.1755 (0.2374)	0.2105 (0.1783)
Alcohol	0.5896 (0.4939)	0.5767 (0.4246)	0.7115 (0.4816)	1.0084** (0.4162)	1.6945*** (0.3519)	0.4387 (0.5400)	-0.5687 (0.4370)
Fertility	-0.7406** (0.3061)	-1.0808*** (0.3579)	-1.3607*** (0.4108)	-1.2823*** (0.4250)	-0.4830 (0.3796)	-0.2257 (0.4264)	-0.1569 (0.3818)
Constant	2.0108 (1.8142)	6.4322*** (1.8871)	6.7879*** (2.1882)	5.6877** (2.1753)	2.7195 (1.7836)	7.0434*** (2.1988)	7.4285*** (1.8308)
Observations	53	53	53	53	53	53	53
R ²	0.791	0.863	0.833	0.856	0.899	0.897	0.807
R ² adjusted	0.759	0.842	0.807	0.834	0.883	0.881	0.776
F-statistic	29.94	26.24	18.77	24.51	61.95	35.14	25.25

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Tables 3, 4 and 5 suggest age-specific differences in the impact of economic policy uncertainty on suicidal behaviour. In particular, we observe that economic policy uncertainty is significantly associated with increased male suicide rates only for the younger segments (15–34) and the older segments (65–84) of the US male population, while the female population across all ages is found to be resilient to changes in economic policy uncertainty. The fact that only younger and older males are affected by economic policy uncertainty could be due to increased insecurity of young entrepreneurs entering the labour market and to uncertainty about pensions, respectively.⁵ Increased unemployment leads to significant increases in male suicide rates between the 35–64 age group and female suicide rates in the 45–64 age group (e.g. the middle aged, and those close to pension). Higher economic growth is significantly associated with higher male suicide rates between 25–34 and 65–84, while with lower male suicide rates between 45–54. Females seem to be resilient to variations in economic growth. Higher GDP is significantly associated with lower male suicide rates in the 25–34 and 55–84 age groups, while in the female population is significantly associated with lower suicide rates among all age groups. Higher divorce rates significantly increase male suicide rates for the younger segments (15–34) and the older segments (65–84) of the US population, while reduce suicide rates of the middle-aged (35–64) males and middle-aged (25–64) females. The effects of changes in alcohol consumption on changes in suicide rates differ by gender and age group, which demonstrates once again that focusing on the total population alone can mask divergent effects that can cancel each other out when subgroups are combined. In particular, increases in alcohol consumption are associated with increased male suicides rates in the 55–64 age group and increased female suicides rates in the 45–64 age group, while reduced male suicide rates in the 35–44 age group. Finally, higher fertility leads to lower suicide rates of males in the 35–44 age group and lower suicide rates of the most fertile female population (i.e. those in the 15–54 age-groups).

3.2 Robustness Analysis

Given that the economic policy uncertainty variables might be correlated with the unemployment rate, economic growth and income (Jones and Olson 2013; Colombo 2013), which in turn could result in problems of multi-collinearity, we have re-estimated model (1) by: (1) including economic policy uncertainty as the only explanatory variable:

$$SR_{it} = \alpha + \beta_1 EPU_t + \varepsilon_t \quad (2)$$

and (2) including economic policy uncertainty, along with the rest of the socio-demographic variables (i.e. alcohol consumption, divorce rates and fertility rates), but with the rest of the economic variables excluded from the model as:

$$SR_{it} = \alpha + \beta_1 EPU_t + \beta_2 Div_t + \beta_3 Alc_t + \beta_4 Fert_t + \varepsilon_t \quad (3)$$

The results based on models (2) and (3), which are presented in Table 6 suggest qualitatively very similar effects of economic policy uncertainty on suicide mortality

⁵ An interesting, yet worrisome, aspect of our results is that EPU is shown to affect the age-group of 15–24 as well. This could possibly be driven by males in the age range of 22–24 years, during which point in their lives the students enter into the job market after an undergraduate degree. Also, the younger generation is relatively more informed and forward-looking before entering into the job market and a bleak forecast of the economy, due to higher EPU, could lead to the increased impact on suicide rates for this age group.

Table 6 Potential multi-collinearity. Economic policy uncertainty and suicide rates (per 100,000 resident), by sex in the United States, 1950–2013

Gender	(1)	(2)	(3)	(4)	(5)	(6)
Age	Overall	Overall	Male	Male	Female	Female
	All	All	All	All	All	All
EPU	0.0999*** (0.0243)	0.0946*** (0.0228)	0.1484*** (0.0201)	0.1264** (0.0501)	0.0609 (0.0636)	0.1915 (0.1535)
Divorce		0.1326 (0.1007)		0.2770*** (0.0794)		-0.2506** (0.1248)
Alcohol		-0.4613 (0.3990)		-0.0802 (0.1800)		0.5532* (0.3342)
Fertility		-0.1735 (0.1308)		0.1449 (0.1215)		-0.6211** (0.2525)
Constant	1.9680*** (0.1050)	0.8617 (0.6676)	2.1983*** (0.0869)	1.5270** (0.6053)	1.8912*** (0.2916)	4.1110*** (1.1359)
Observations	64	53	64	53	64	53
R ²	0.320	0.488	0.608	0.667	0.0245	0.743
R ² adjusted	0.309	0.446	0.601	0.639	0.00879	0.721
F-statistic	16.83	18.02	54.53	31.96	0.917	16.40

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

compared to those obtained from model (1) and, as such, provide additional robustness to our main findings.⁶

As another robustness check, we explored the possibility of any time-delayed effects related to the manifestation of EPU on suicide rates, by estimating the following model:

$$SR_{it} = \alpha + \beta_1 EPU_t + \beta_2 EPU_{t-1} + \beta_3 Unemp_t + \beta_4 Growth_t + \beta_5 GDP_t + \beta_6 Div_t + \beta_7 Alc_t + \beta_8 Fert_t + \varepsilon_t \quad (4)$$

where EPU_{t-1} is the first (1-year) lag of EPU. The results of this analysis, which are presented in Table 7, suggest no significant evidence of time-delayed effects of EPU on suicide rates, as the first lag of EPU is statistically insignificant across all genders. The results related to the rest of the controlled factors of suicide mortality are in line with those reported in Table 2.⁷

Finally, we examined whether the impact of EPU on suicide rates could evolve asymmetrically. That is, we investigated whether lower EPU could be associated with decreased suicide rates as opposed to higher EPU. To achieve that, we constructed two variables, namely 'high EPU' (i.e. when actual EPU is above the sample EPU average of 112.48) and 'low EPU' (i.e. when actual EPU is below the sample EPU average of 112.48), based on the existing EPU variable. The results of this experiment are presented in Table 8. According to these results, we do not find any significant asymmetric effects between EPU

⁶ The results based on models (2) and (3) for the various age sub-groups are qualitatively very similar to those obtained from model (1), regarding the effect of EPU on suicide rates, and thus not presented, however, are available upon request from the authors.

⁷ The results of this analysis for the various age sub-groups point to similar conclusions. These results are available upon request from the authors.

Table 7 Time-delayed effects of economic policy uncertainty on suicide rates (per 100,000 resident), by sex in the United States, 1950–2013

	(1)	(2)	(3)
Gender	Overall	Male	Female
Age	All	All	All
EPU	0.1484** (0.0619)	0.1734*** (0.0567)	0.0718 (0.1164)
1st Lag of EPU	0.0713 (0.0612)	0.0936 (0.0597)	−0.0062 (0.1004)
Unemployment	0.0719* (0.0391)	0.0722** (0.0350)	0.0901 (0.0714)
Growth	0.0052* (0.0028)	0.0069** (0.0028)	0.0010 (0.0064)
GDP	−0.1933*** (0.0550)	−0.1402*** (0.0510)	−0.3875*** (0.1119)
Divorce	0.0126 (0.0888)	0.1805*** (0.0649)	−0.4637** (0.2220)
Alcohol	−0.1071 (0.1958)	−0.2983 (0.1869)	0.5852 (0.3553)
Fertility	−0.0811 (0.1650)	0.1515 (0.1706)	−0.7817*** (0.2851)
Constant	3.2737*** (0.8278)	3.0418*** (0.8189)	4.5522*** (1.5266)
Observations	53	53	53
R ²	0.704	0.799	0.846
R ² adjusted	0.651	0.763	0.818
F-statistic	14.86	58.03	22.02

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

and suicide rates. Put differently, low levels of EPU do not have any significant suicide-reducing effects, as the coefficients of “Low EPU” are statistically insignificant. Yet, only high levels of EPU are associated with increased suicide mortality only for the male population in the United States.⁸

4 Summary and Concluding Remarks

While it has long been recognised that periods of economic uncertainty, characterised by increased unemployment and lower economic activity, are associated with increased suicide rates, no study has examined the impact of policy-related economic uncertainty on suicide mortality. In this study we examine whether policy-related economic uncertainty has an impact on suicide mortality in the United States over the period 1950–2013, while controlling for several other socioeconomic determinants of suicide mortality, as well as

⁸ Once again, the results for the various age sub-groups point to similar conclusions and thus are not presented, however, are available upon request from the authors.

Table 8 Asymmetric effects of economic policy uncertainty on suicide rates (per 100,000 resident), by sex in the United States, 1950–2013

Gender Age	(1) Overall All	(2) Overall All	(3) Male All	(4) Male All	(5) Female All	(6) Female All
High EPU	0.2210** (0.1044)		0.2073** (0.0952)		0.2332 (0.1531)	
Low EPU		0.0147 (0.0571)		0.0244 (0.0343)		-0.0061 (0.1404)
Unemployment	0.1043 (0.0694)	0.0278 (0.0261)	0.1203* (0.0644)	0.0525 (0.0349)	0.0788 (0.1127)	-0.0414 (0.0664)
Growth	0.0070 (0.0058)	0.0060* (0.0032)	0.0080 (0.0053)	0.0040 (0.0034)	0.0044 (0.0087)	0.0129 (0.0081)
GDP	-0.2146** (0.1034)	-0.1119** (0.0363)	-0.1056 (0.0997)	-0.0877 (0.0594)	-0.5585*** (0.1440)	-0.2537* (0.1314)
Divorce	-0.0064 (0.2145)	0.1473*** (0.0293)	0.2524 (0.2054)	0.1394*** (0.0399)	-0.7213** (0.3014)	0.1748* (0.0835)
Alcohol	-0.2210 (0.2096)	0.3285** (0.1232)	-0.2967 (0.2088)	-0.3116 (0.2120)	0.1437 (0.2921)	0.2632*** (0.0833)
Fertility	-0.0496 (0.4552)	0.0288 (0.0981)	0.2533 (0.4026)	-0.1355 (0.1154)	-0.9600 (0.7107)	0.4616 (0.2995)
Constant	3.6548*** (1.0356)	2.3132*** (0.5816)	2.7498** (1.0901)	4.0029*** (1.0854)	6.7732*** (1.3890)	-1.6434 (2.4079)
Observations	37	16	37	16	37	16
R ²	0.652	0.942	0.553	0.931	0.855	0.950
R ² adjusted	0.569	0.892	0.445	0.871	0.820	0.906
F-statistic	10.12	330.8	10.50	205.4	45.84	453.8

Heteroscedasticity and autocorrelation (HAC) adjusted standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

age- and gender-specificities. The results of the analysis, which remain robust to a battery of checks, reveal that increased economic policy uncertainty is associated with increased suicide mortality of the youngest and the oldest segments of the male population in the United States, while the female population across all ages is found to be resilient to policy-related economic uncertainty.

Our results have important policy implications. Economic uncertainty is unavoidable, however, what should be avoided, via clear cut transparency in the policy making of the US government, is extreme increases in uncertainty (i.e. beyond the mean). Since as our results show, it is higher uncertainty that tends to cause increases in suicide rates, but lower uncertainty does not necessarily reduce suicide rates. So, from a macroeconomic perspective, while policy making can prevent increases in suicide rates by keeping exorbitant increases in uncertainty at check, suicide rates cannot be reduced by lower macroeconomic policy uncertainty. But, an important component of the policy making should be the information conveyed to the general public, and in particular, the young and the old males, that the government is making strong efforts in ensuring lower-levels of uncertainty. This line of reasoning makes sense, as this uncertainty is newspaper-based, and hence, conveying strong policy measures to keep uncertainty at check should not be a problem. At the

same time, at a micro-level, given that EPU increase causes the suicide rates in younger and older males to increase, government should aim to provide counselling services to vulnerable candidates, though identifying such cases could be a major informational problem. However, in this regard, transparency of policy making and conveying it to the economy in general, again takes center stage. The bottom line of our analysis is that uncertainty should be kept within bounds and attempts to do so must be well-publicised. Of course, at the same time, the importance of other predictors in affecting suicide rates like unemployment and growth slowdown cannot be ignored, but these variables are likely to improve with reduction in EPU.

As a potential avenue, that we leave for future research, it would be interesting to examine whether any threshold effects related to economic policy uncertainty on suicide mortality can be determined endogenously in the spirit of Dagenais (1969). In addition, it might also be interesting to perform a time-varying analysis to see how the relationship between suicide rates and economic policy uncertainty has evolved over time.

Acknowledgments We would like to thank the editor (Filomena Maggino) and three anonymous reviewers for very insightful comments and suggestions on a previous version of this paper. The usual disclaimer applies.

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