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Back to school blues: Seasonality of youth suicide and the academic calendar☆

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ABSTRACT

Previous research has found evidence of academic benefits to longer school years. This paper investigates one of the many potential costs of increased school year length, documenting a dramatic decrease in youth suicide in months when school is not in session. A detailed analysis does not find that other potential explanations such as economic conditions, weather or seasonal affective disorder patterns can explain the decrease. This evidence suggests that youth may face increased stress and decreased mental health when school is in session.

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1. Introduction

Suicide is the third leading cause of death among youth and the suicide rate of 15–19 year olds tripled between 1950 and 1990. Over the same time period, suicide rates for older individuals decreased. A significant literature exists exploring the determinants of youth suicide, with recent studies showing that risky behaviors such as alcohol consumption and sexual activity are associated with youth suicide (Carpenter, 2004; Sabia, 2008). Despite this literature, no previous work (to our knowledge) has directly explored the relationship between school and youth suicide, even though teens are in school for over three-quarters of the calendar year. This paper examines the seasonality of youth suicide with a specific focus on how youth suicide may be related to the typical academic calendar.

Using a panel of state suicide rates between 1980 and 2004, our data show during months that students tend to be on break from school (June, July, August and December), youth suicide is significantly lower than the rest of the year. This pattern does not hold for adults. One possible explanation for the summer decline in youth suicide is the prevalence of seasonal affective disorder (SAD), where individuals become more depressed during the winter months. SAD is most prominent in northern states where the sunlight is limited during the winter, but relatively abun-

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dant during the summer. Results show that suicides also decrease during the month of December, when students are typically on winter break, and further analysis shows that the suicide decrease in the summer months is not driven by northern states. Furthermore, SAD affects youth females significantly more than youth males, but males are driving the results below. In addition to investigating the role that SAD plays, economic conditions, weather patterns and divorce rates are also considered and when controlling for these potential factors, the seasonal youth suicide pattern remains.

Recent work shows the benefits of increased schooling,[1] but rarely is the negative impact of schooling considered. Our results suggest that the increased stress that students face throughout the school year may exacerbate mental health issues and increase youth suicide. This potential cost of education should be taken into consideration as school districts debate increasing the length of the academic school year.

2. Background

The seminal work on suicide in economics by Hamermesh and Soss (1974) develops a rational-suicide theory that argues that suicide rates should increase as individuals get older. While their data from the early half of the 1900s support their predictions that older age groups should have higher suicide rates, recent trends in suicide across age groups tend to deviate from their findings. Most of the research on youth suicide looks at the patterns of youth suicide across ages, time periods, geography and races.

Freeman (1998) shows youth suicide rates increase when cohort size increases and competition for resources becomes greater. Cutler, Glaeser, and Norberg (2001) use National Longitudinal Study of Adolescent Health (AddHealth) data and mortality data from the NCHS and find that unsuccessful youth suicide attempts are usually “cries for help”.[2] Cutler et al. (2001) also find that teens are more likely to attempt suicide if they hear of another teen attempting suicide and that the rise in youth suicide is strongly correlated with changes in the fraction of youth with divorced parents. They also present stylized facts showing that rural areas are more likely to have high suicide rates, compared to urban areas.

Molina and Duarte (2006) use data from the US National Youth Risk Behavior Surveys to extensively analyze the relationship between youth suicide attempts and demographic and psychosocial characteristics. They find that female youth attempt suicide more often than youth males (although youth male suicide rates are significantly higher than youth female suicide rates) and American Indian and Alaskan native adolescents are more likely to consider suicide than other races. Drug consumption is positively related to youth suicidal behavior, as is educational failure, access to a gun, low self-esteem, the number of sexual partners and becoming pregnant. On the other hand, they find that participation in sports is negatively related with youth suicidal behavior.

While these papers provide characteristics associated with youth suicide, they do not claim to find a causal effect. A related line of literature has attempted to identify the causal determinants of youth suicide. Markowitz, Chatterji, and Kaestner (2003) find that taxes on beer and drunk-driving laws lower the suicide rate for males 15–19 and 20–24. Carpenter (2004) looks at the effect of states adopting zero tolerance alcohol laws on suicide. The adoption of the state laws, which revoke the driver’s licenses of individuals under 21 if any alcohol is found in their blood, are associated with a significant decrease in male suicide for age 15–17 and 18–20. Using a similar identification strategy as Carpenter, Sabia (2008) shows that when states enact parental involvement laws, female youth suicide significantly decreases. Although research has shown that alcohol consumption, poor self-esteem and sexual activity is related to youth suicide, there is little discussion about the fact that these risky behaviors often originate from interactions with peers at school.

Lastly, there has been a recent series of papers suggesting benefits to longer school calendars. Marcotte (2007), Marcotte and Hemelt (2008), and Hansen (2008) take advantage of variation in snow days to address the effect of instructional days on student performance, finding that more days raises test scores on standardized exams. Similarly, Hansen (2008) and Fitzpatrick et al. (2011) utilize variation in test-timing to assess the effect of additional instruction days, finding similar, but smaller estimates. Furthermore, Sims (2008) finds similar effects utilizing variation in mandated school-start dates. Following this line of literature, Marcotte and Hansen (2010) discuss the policy implications of these results in regards to school calendar policies.

Without taking away from the benefits that are associated with obtaining education, there must be a discussion of the potential costs that come from the social and academic pressure of school. Our paper begins a serious line of inquiry about the relationship between school and resulting pressures or stresses that are ultimately manifested through suicide. In addition to identifying a large contributing factor of youth suicides, we have also identified a potential cost to weigh against the benefits of increased instructional days.

3. Data

The data used in the paper comes from a variety of sources. The mortality data is from the Multiple Cause-of-Death Public Use Files, which are published annually by the National Center for Health Statistics. Between 1977 and 1999, the International Classification of Diseases, 9th Edition (ICD-9) was used to code mortality and currently the ICD-10 is used. Suicides are defined in the ICD-9 using code 350 in the “34 Recode” classification and code 040 in ICD-10 using the “39 Recode” classification. In the years we are investigating, 1980–2004, the public use mortality

[1] Work by Marcotte (2007), Marcotte and Hemelt (2008), Hansen (2008) and Fitzpatrick, Grissmer, and Hastedt (2011) on the benefits of increased schooling is discussed below.

[2] This is consistent with Marcotte’s (2003) finding that individuals who previously attempted suicide have higher incomes than their peers who considered suicide, but did not make an attempt.

Table 1
Monthly suicide rate averages, 1980–2004.

Month	(1) Suicide rate	(2) 15–18 suicide rate	(3) 19–25 suicide rate
January	11.94	8.73	14.93
	(3.56)	(6.96)	(7.78)
February	10.95	7.82	13.35
	(3.18)	(6.44)	(6.83)
March	12.35	8.35	14.67
	(3.46)	(6.58)	(7.35)
April	12.04	7.86	14.30
	(3.44)	(6.46)	(7.40)
May	12.30	7.94	14.47
	(3.40)	(6.27)	(7.44)
June	11.89	6.39	14.45
	(3.28)	(5.47)	(7.15)
July	12.28	6.48	14.69
	(3.56)	(5.66)	(7.56)
August	12.23	6.72	14.82
	(3.48)	(5.48)	(7.57)
September	11.54	7.31	13.91
	(3.56)	(6.08)	(7.21)
October	11.67	7.94	14.28
	(3.25)	(6.25)	(6.82)
November	11.21	7.67	14.00
	(3.18)	(6.15)	(7.39)
December	10.92	6.74	13.60
	(3.24)	(6.21)	(7.01)
Total	11.78	7.49	14.29
	(3.40)	(6.22)	(7.31)

Each monthly cell contains 1275 monthly observations that are population-weighted. The bottom row is the average over all months and contains 15,300 observations. Standard deviations are shown in parentheses.

data contains information on the state of death, month of death and age and race of the deceased person. Suicide data is turned into a suicide rate by multiplying the monthly number of suicides in a state by 100,000 and dividing by the population in order to get the monthly suicide rate per 100,000. In order to make monthly rates comparable to annual rates, the suicide rates are multiplied by 12.

In order to control for a variety of factors that may be associated with suicide, divorce rates, unemployment rates and precipitation are included in several specifications. The divorce rates are obtained from the Vital Statistics, similar to the data used in the Wolfers (2006) and Friedberg (1998) papers on divorce laws. Unemployment rates are from the Bureau of Labor Statistics and are available at the state level for every month. Data on precipitation comes from the National Oceanic and Atmospheric Administration (NOAA), who provide monthly precipitation in inches by state.

3.1. Descriptive statistics

The seasonal patterns of youth suicide can be seen by examining descriptive statistics. Table 1 shows the average monthly suicide rate per 100,000 for all individuals in column 1, as well as the suicide rate for 14–18 year olds and 19–25 year olds in columns 2 and 3. The average over all months is reported in the bottom row and each rate is weighted by the population of interest. In Table 1, the 14–18 year old suicide rate drops noticeably in June, July and August and then again in December, while the other two columns do not exhibit the same pattern. In fact, for both the entire population and 19–25 year olds, the suicide rates in the months of June, July and August are all above the respective annual suicide rate. When converted to a percentage, the summer decline in youth suicides is nearly twice as large as the estimated effect of zero tolerance alcohol laws on youth suicide (Carpenter, 2004).

The implications from Table 1 can be seen clearly in Fig. 1, which graphically shows the average suicide rates for 14–18 year olds and 19–25 year olds over the course of the year. The solid black line depicts the suicide rate for 14–18 year olds and the dotted line represents the suicide rate of 19–25 year olds. In Fig. 1, the decrease in suicides for 14–18 year olds during the summer months is stark, while the 19–25 year olds see a slight rise in suicide rates during the summer, then a gradual non-monotonic decrease until December.

Fig. 1 shows that the decrease in suicide during the summer months dissipates in the 19–25 age group, but it may cause one to wonder what the monthly suicide rate is for each age group. Not all 18 year olds are in high school, particularly those that turn 18 over the summer. An 18 year old born in the summer months that commits suicide would most likely not be in high school and a summer vacation at the age of 18 would not eliminate any high school stress. This is not to say that we should not see a drop in suicide during the summer for 18 year olds, however, if 18 year olds were driving the pattern in Fig. 1, the effect of summer vacation would be in question. Furthermore, if summer vacations in high school are the cause of the summer suicide decline, the pattern of low suicide in the summer should disappear for 19 year olds.

To explore whether 18 year olds are driving the pattern seen in Fig. 1, Fig. 2 plots the age-specific suicide rates over the year. The black lines represent the monthly suicide rates of those 16–18 years old, with the solid black line depicting 16 year olds, the dotted black line showing 17 year olds and the dashed line corresponding to 18 year olds. In the figure, it is clear that between May and June, there is a sharp drop in the suicide rate that persists roughly until September. The 19–21 year old suicide rates are shown in gray, and in contrast to the younger ages, the summer months of June, July and August are not associated with a decrease in suicide.[3]

The table and figures above convincingly show that there is a clear seasonal pattern for youth suicides, but the descriptive statistics are unable to address a number of important issues that may be driving the pattern seen in Figs. 1 and 2. Economic and social conditions and weather anomalies may play a role in the seasonal pattern. The issue of seasonal affective disorder (SAD) must also be addressed. If youth with SAD are more prone to commit suicide when there is less sunlight, then states with extreme seasons may be driving the pattern. In order to convincingly rule out these factors as potential drivers of the seasonal pattern, the next section investigates the effect of summer months on suicide in a panel data framework.

[3] The other ages in the study (14 and 15 year-olds), follow a similar pattern as 16 and 17 year-olds, but at a significantly lower rate.

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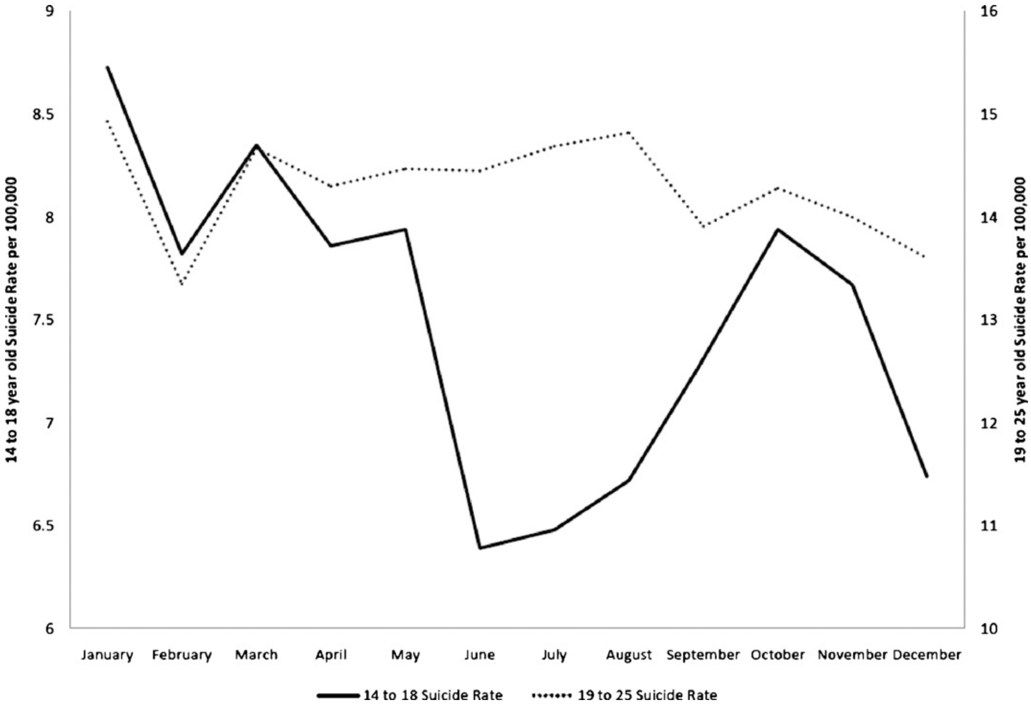

Fig. 1. Average suicide rates by month, 1980–2004.

4. Results

This section estimates the size of the decrease in suicides for youth in the summer and explores whether the drop can be explained by observable characteristics. The seasonal pattern in youth suicides is compared with adult suicide patterns and the stability of the summer decrease is analyzed. In order to determine the role that SAD plays, the summer decrease is analyzed by region and by gender. The summer pattern of other common causes-of-death for the

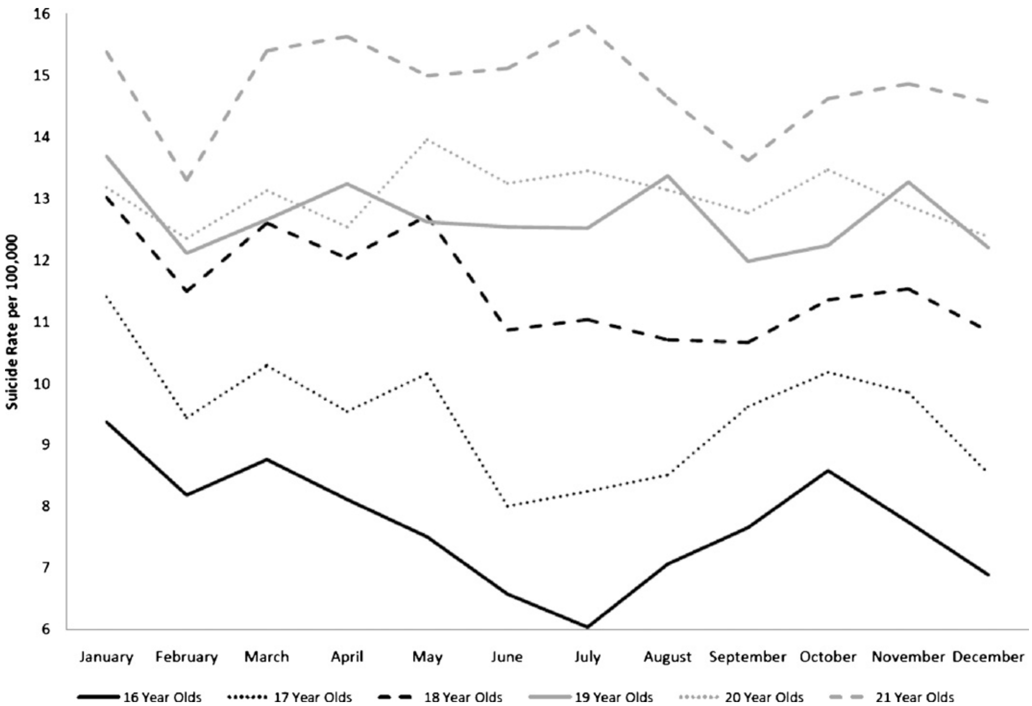

Fig. 2. Age specific monthly suicide rates, 1980–2004.

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Table 2
Seasonality in the suicide rate-youth vs. adult.

	Youth suicide rate			Adult suicide rate		
	(1)	(2)	(3)	(4)	(5)	(6)
June	**−0.93***** **(0.22)**	**−0.92***** **(0.21)**	**−0.96***** **(0.23)**	**0.49***** **(0.19)**	**0.49***** **(0.08)**	**0.48***** **(0.08)**
July	**−0.83***** **(0.23)**	**−0.83***** **(0.21)**	**−0.89***** **(0.22)**	**0.94***** **(0.19)**	**0.94***** **(0.08)**	**0.93***** **(0.09)**
August	**−0.60***** **(0.22)**	**−0.59***** **(0.20)**	**−0.56**** **(0.22)**	**0.85***** **(0.19)**	**0.85***** **(0.07)**	**0.85***** **(0.07)**
September	–	–	–	–	–	–
October	0.63*** (0.24)	0.63*** (0.19)	0.65*** (0.21)	0.08 (0.18)	0.08 (0.09)	0.12 (0.09)
November	0.36 (0.23)	0.36 (0.25)	0.48* (0.27)	−0.42** (0.18)	−0.42*** (0.11)	−0.39*** (0.11)
December	−0.57** (0.23)	−0.57** (0.26)	−0.52* (0.28)	−0.66*** (0.18)	−0.67*** (0.10)	−0.64*** (0.12)
January	1.42*** (0.25)	1.43*** (0.25)	1.62*** (0.29)	0.34* (0.19)	0.34** (0.13)	0.30*** (0.11)
February	0.51** (0.24)	0.51*** (0.18)	0.58*** (0.19)	−0.73*** (0.18)	−0.73*** (0.08)	−0.71*** (0.09)
March	1.04*** (0.24)	1.04*** (0.17)	0.99*** (0.19)	0.83*** (0.19)	0.84*** (0.08)	0.85*** (0.08)
April	0.55** (0.24)	0.56** (0.24)	0.51* (0.27)	0.53*** (0.18)	0.54*** (0.07)	0.53*** (0.08)
May	0.62*** (0.24)	0.63*** (0.22)	0.56** (0.25)	0.82*** (0.19)	0.83*** (0.08)	0.83*** (0.08)
Divorce rate			0.007*** (0.001)			0.002** (0.001)
Precipitation			0.02 (0.04)			0.02 (0.01)
Unemployment rate			−0.01 (0.07)			0.02 (0.06)
Mean of dependent variable	7.42	7.42	7.42	12.82	12.82	12.82
State fixed effects	No	Yes	Yes	No	Yes	Yes
Year fixed effects	No	Yes	Yes	No	Yes	Yes
N	15,300	15,300	13,536	15,300	15,300	13,536
R^2	0.01	0.19	0.18	0.02	0.64	0.67

Standard errors are clustered at the state level in columns 2, 3, 5 and 6. Robust standard errors are reported in columns 1 and 4. Each regression is population weighted.
Columns 3 and 6 drop observations due to missing precipitation and divorce rate data.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

youth are analyzed in order to rule out the suicide pattern as part of an overall youth death trend.

4.1. Youth vs. adults

Youth suicides are defined in the current analysis as any suicide between the ages of 14 and 18. This accounts for roughly 91% of all youth suicides. Using a larger range of ages does not change the implications of our results, but including suicides committed by those younger than 14 are rare and including or excluding them has no bearing on our findings.

The regressions in Table 2 follow from Eq. (1), where the suicide rate in state s, month m and year y is regressed on state, month and year dummies, along with the controls. The regressions are weighted by the population of the dependent variable.

$$suiciderate_{smy} = m_m + y_y + s_s + precip_{smy} + X'_{smy}\beta + u_{smy}. \quad (1)$$

Columns (1) through (3) report the coefficients when youth suicide is the dependent variable (14–18 years old). Robust standard errors are reported in column 1 and standard errors clustered at the state level are reported in columns 2 and 3 in order to correct for any autocorrelation that may exist in states over time (Bertrand, Duflo, & Mullainathan, 2004). For these specifications, we chose to omit September, as that is typically the first full month of the school year. The results show that the June, July and August suicide rates (bolded in Table 2) are significantly lower than the omitted month, September. The only other month that has a negative coefficient is December, however the magnitude of the December coefficient is significantly smaller (at the 10% level) in absolute value than the June coefficient. The months that students are most likely in school all have significantly positive coefficients, with January and March reporting the highest rates of suicide relative to September. The coefficients are robust to the inclusion of state and year fixed-effects, as well as controls for divorce rate, precipitation and the unemployment rate.

Columns (4) through (6) show the results of regressions using the adult suicide rate as the dependent variable. Consistent with the tables and figures above, the adult suicide rate does not decrease during the summer months.

In fact, July and August have the highest rates of adult suicide. When comparing the youth suicide results to the adult results, it appears that youth suicide is least likely to occur in months when students are on summer vacation, while adult suicide is most likely to occur during those same months, suggesting that youth and adult suicide follow significantly different seasonal patterns. However, adults and youth differ on many dimensions beyond school, justifying further exploration of suicide rates for age groups closer to 18 years old.

In Table 3, Eq. (1) is reestimated using 14–17 year olds, 17, 18, 19 and 20 year olds, as well as those 19–25 years old as dependent variables. In order to not lose observations as a result of missing data from the demographic controls, only state and year fixed effects are included in the regressions, however, including the demographic controls does not change the implications of the results. Similar to Table 2, all regressions are weighted by the population of interest and standard errors are clustered at the state level.

The results in Table 3 provide further evidence that school summer vacation is associated with a decrease in youth suicide. Column (1), reporting the monthly coefficients for 14–17 year olds, is consistent with the results in Table 2, with the summer months associated with the most significant decrease in the suicide rate. The 17 year old suicide rate results in column (2) are the same sign as the 14–17 year olds in column (1), with the coefficients in the summer months being slightly larger in magnitude for 17 year olds than for 14–17 year old group.

The effect of the summer vacation still remains for 18 year olds in column (3), as there is a significant difference between suicide rates in May compared with June, July or August. However, there is not a significant difference between the suicide rate in the summer months and in September. This may be the result of the fact that only 18 year olds born in a small window, which is dependent on school age cutoff dates, are 18 years old in September of their senior year of high school. The majority of seniors are 17 years old when they start their senior year. By September, most 18 year olds have started pursuing post-secondary careers.

The results in column (4) show that the pattern of decreased suicides during the summer months disappears for 19 year olds. The summer decrease in suicides is also absent for 20 year olds in column (5) and the 19–25 age group in column (6). Taken all together, the results in Table 4 provide strong evidence that summer vacation for high schoolers is strongly associated with a decrease in suicide. The summer decrease disappears once individuals tend to be out of high school.

In order to simplify the interpretation of the coefficients in Tables 2 and 3, Table 4 reports results of regressions that replace the monthly dummy variables with a summer dummy variable for the months of June, July and August. This alteration yields the following regression:

$$suiciderate_{mys} = summer_m + y_y + s_s + u_{smy}. \quad (2)$$

The results from the regression of Eq. (2) are reported in Table 5, where each regression is weighted by the population of interest. Consistent with the results above, 14–17 year olds and 17 year olds have a significantly lower suicide rate in summer compared to the rest of the year. Specifically, the summer months decrease the 14–17 year old suicide rate by 1.38 per 100,000 and the 17 year old suicide rate by 1.64 per 100,000. By the time 18 year olds reach the summer, their suicide rate is no different in the summer compared to the rest of the year. The 19 year old suicide rate is higher in the summer relative to other months, however, the summer increase is insignificant for 20 year olds. The 19–25 age group has a significantly higher suicide rate in the summer than the rest of the year.

Tables 2–4 show that there is a significant effect of summer on suicide for the youth that disappears when they reach 18 years old. While the results above address a number of questions about the differential effect between youth and adults, there are still regional and gender difference that must be explored, as well as whether the summer effect is consistent over time and if youth suicide follows the same pattern as other leading causes-of-death.

4.2. Stability of the summer effect

In order to determine the stability of the summer effect found above, Eq. (2) is estimated separately for each year between 1980 and 2004. Figs. 3 and 4 plots the summer coefficient for Eq. (2) with the year on the horizontal axis and the yearly effect of summer months on the youth suicide rate on the vertical axis. Every year the coefficient estimate of summer is negative, and the coefficient is insignificant in only four of the years. In 16 of the 25 years, the coefficient is between −1.00 and −2.00 per 100,000.

While the strong summer pattern appears generally stable over time, since the mid-1990s, the value of the coefficient has become slightly smaller in magnitude. If this were to become more pronounced in the future, it would be consistent with the general movement towards lengthening the school calendar. In the past, the school year typically began in September and ended in May, but more recently, the beginning of the school year has moved to mid-August and ends in June.

Fig. 4 plots the yearly summer coefficient for 19–25 year old suicides. The graph shows that the 19–25 year old summer coefficient is also generally stable, but the coefficient is centered slightly above zero. This is consistent with the coefficient of 0.54 found in Table 4. The most noteworthy result from Fig. 4 is that the summer coefficient for 19–25 year olds is negative in only four years, and each of these years, they are highly insignificant. Together, Figs. 3 and 4 provide further evidence that the summer suicide decrease is absent for those out of high school, but is stable and negative for youth over time.

4.3. Seasonal affective disorder

Another possible explanation for the youth suicide pattern is seasonal affective disorder (SAD). Estimates of the prevalence of SAD in the US ranges from 1.5 to 10% of the population (Kasper, Wehr, Bartko, Gaist, & Rosenthal, 1989; Rosen et al., 1990), and cause individuals to experience recurring episodes of depression during the winter months that disappear during the summer (Rosenthal et al., 1984). If the seasons were to drive the results above, it is unlikely

Table 3
Seasonality in the suicide rate-specific age results.

	14–17 years old (1)	17 years old (2)	18 years old (3)	19 years old (4)	20 years old (5)	19–25 years old (6)
June	**−1.20*** **	**−1.63*** **	**0.19**	**0.56**	**0.49**	**0.54*** **
	(0.24)	**(0.48)**	**(0.54)**	**(0.44)**	**(0.47)**	**(0.18)**
July	**−1.13*** **	**−1.38** **	**0.36**	**0.54**	**0.68**	**0.78*** **
	(0.21)	**(0.53)**	**(0.50)**	**(0.52)**	**(0.50)**	**(0.22)**
August	**−0.76*** **	**−1.12** **	**0.04**	**1.39*** **	**0.37**	**0.91*** **
	(0.21)	**(0.53)**	**(0.51)**	**(0.45)**	**(0.53)**	**(0.23)**
September	–	–	–	–	–	–
October	0.62***	0.55	0.68	0.26	0.70	0.37
	(0.19)	(0.46)	(0.48)	(0.46)	(0.67)	(0.24)
November	0.23	0.23	0.86	1.29**	0.11	0.09
	(0.29)	(0.48)	(0.58)	(0.57)	(0.42)	(0.32)
December	−0.76**	−1.09*	0.18	0.22	−0.39	−0.31
	(0.30)	(0.59)	(0.44)	(0.48)	(0.57)	(0.26)
January	1.19***	1.77***	2.36***	1.71**	0.41	1.02***
	(0.25)	(0.59)	(0.54)	(0.64)	(0.53)	(0.23)
February	0.43**	−0.18	0.82	0.13	−0.42	−0.56***
	(0.19)	(0.53)	(0.56)	(0.46)	(0.52)	(0.20)
March	0.81***	0.67		0.68	0.36	0.75***
	(0.18)	(0.41)	(0.51)	(0.50)	(0.59)	(0.17)
April	0.35	−0.08	1.37**	1.26**	−0.23	0.39*
	(0.21)	(0.52)	(0.56)	(0.61)	(0.51)	(0.22)
May	0.27	0.53	2.06***	0.64	1.19**	0.55**
	(0.25)	(0.54)	(0.61)	(0.53)	(0.51)	(0.24)
Mean of dependent variable	6.40	9.37	11.49	12.57	12.93	14.12
N	15,300	15,300	15,300	15,300	15,300	15,300
R^2	0.15	0.06	0.06	0.05	0.05	0.25

All regressions contain state and year fixed effects, but not demographic controls.
Standard errors clustered at the state level are reported. Each regression is population weighted.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 4
The summer effect-age specific results.

	14–17 years old (1)	17 years old (2)	18 years old (3)	19 years old (4)	20 years old (5)	19–25 years old (6)
Summer	−1.38***	−1.64***	0.30	1.39***	0.49	0.54***
	(0.10)	(0.20)	(0.50)	(0.45)	(0.47)	(0.18)
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	15,300	15,300	15,300	15,300	15,300	15,300
R^2	0.14	0.05	0.06	0.05	0.05	0.25

All regressions contain state and year fixed effects, but not demographic controls.
Standard errors clustered at the state level are reported. Each regression is population weighted.
*Significant at the 10% level.
**Significant at the 5% level.
*** Significant at the 1% level.

Table 5
The summer effect by gender.

	Males		Females	
	14–18 years old (1)	19–25 years old (2)	14–18 years old (3)	19–25 years old (4)
Summer	−1.90***	0.78***	−0.65***	0.19**
	(0.19)	(0.20)	(0.08)	(0.08)
Mean of dependent variable	11.66	23.78	2.95	4.17
State fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
N	15,300	15,300	15,300	15,300
R^2	0.15	0.22	0.05	0.07

All regressions contain state and year fixed effects, are weighted by population.
Standard errors clustered at the state level are reported.
** Significant at the 5% level.
*** Significant at the 1% level.

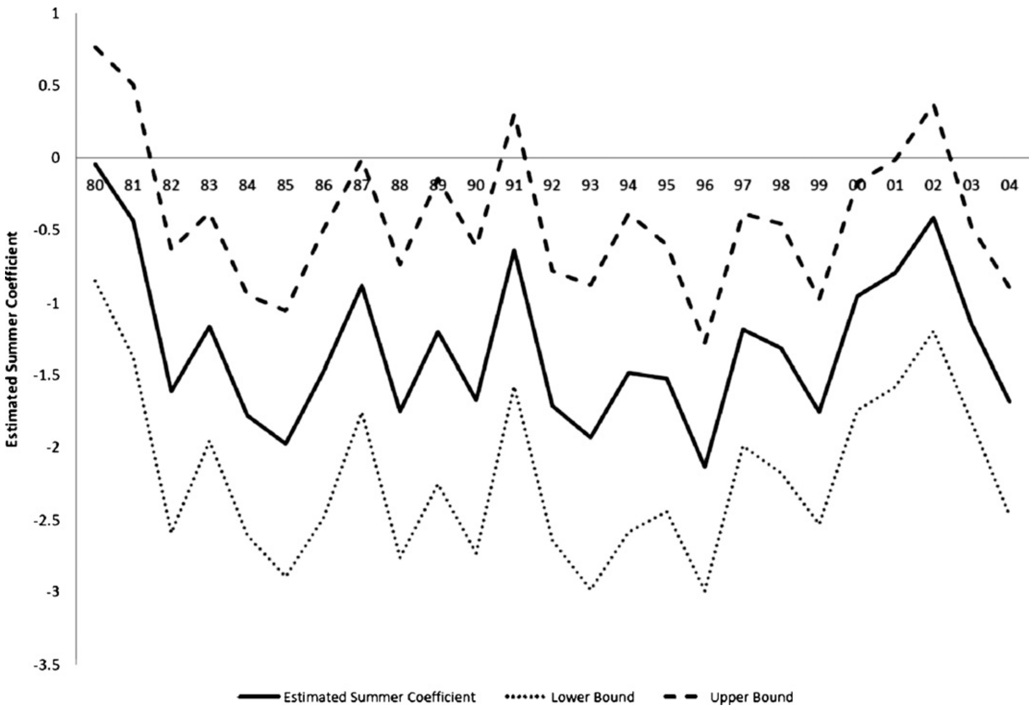

Fig. 3. Stability of youth summer effects.

there would be such a sudden drop in the suicide rate. In the regressions and figures above, there is a sharp decrease in suicide in June compared with May, not a gradual suicide decline throughout the spring that a SAD driven pattern would predict.

However, in order to convincingly eliminate SAD as a possible explanation for the summer effect, the analysis must go beyond looking at descriptive statistics. There are two prominent characteristics of SAD, gender and regional differences, that can be exploited in order to more accu-

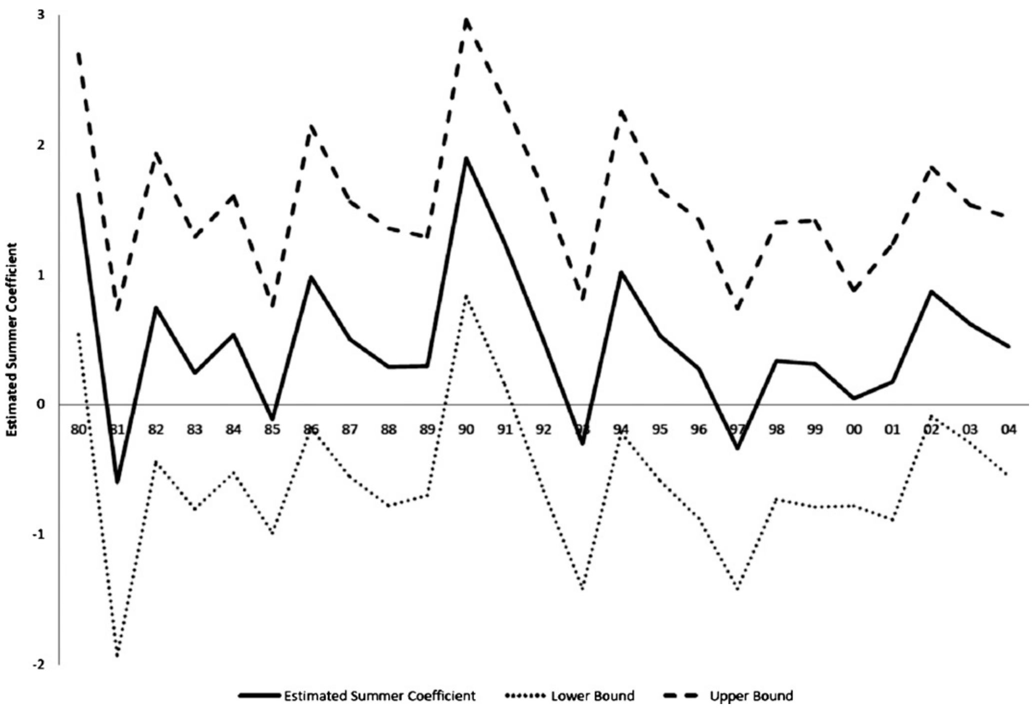

Fig. 4. Stability of 19–25 year old summer effect.

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rately determine the role that SAD plays in the results above. Specifically, females are diagnosed with SAD three to nine times more than males (Kasper & Neumeister, 1994; Lucht & Kasper, 1999; Thompson & Isaacs, 1988; Weissman & Klerman, 1977; Wirz-Justice et al., 1986). If SAD were playing a significant role, then female suicide would be driving the summer effect, while the change in male suicide over the summer would not be as large. By analyzing the male and female summer effects separately, it is seen that males are driving the results above, further diminishing the role of SAD in the youth summer effect.

A second important characteristic of SAD is that exposure to sunlight plays a significant role in the disorder (Molin, Mellerup, Bolwig, Scheike, & Dam, 1996). Prior studies have shown that the prevalence of SAD in Florida is only 1.5%, but 9% in the northern US (Booker & Hellekson, 1992; Rosen et al., 1990). Other studies have shown that there is a positive relationship between the prevalence of SAD and latitude in the US (Mersch, Middendorp, Bouhuys, Beersma, & van den Hoofdaker, 1999). This implies that states with harsher winters should experience a larger decrease in suicide over the summer, compared to states with mild winters. By examining the differential summer effect between youth and 19–25 year olds in different parts of the country, the role that SAD plays in suicide, as well as in the summer effect can be analyzed. The next two sections explore the gender and regional differences in the youth summer effect.

4.3.1. Gender differences

As mentioned above, SAD affects females three to nine times more than males. In order to estimate the role SAD plays in the summer effect, male and female suicide rates are measured separately. Table 5 reports the regressions of youth and 19–25 year old male and female suicides on the summer variable, along with state and year fixed-effects. Again, the demographic controls are omitted in order to retain all the observations, but the same conclusions are reached when including them in the regression.

Columns (1) and (2) of Table 5 report the results of male suicide rates for 14–18 year olds and 19–25 year olds, while columns (3) and (4) report the female suicide results. The summer effect for males is larger than females, with male the differential being 2.68 per 100,000 while the female differential is 0.84 per 100,000. While this does not conclusively rule out SAD as a driver of the summer effect, if SAD were playing a significant role in the results above, the female differential would be significantly larger than the male differential.[4]

4.3.2. Regional summer effect

The previous section clearly shows that males are driving the summer effect, but because SAD is a disorder related to sunlight, it is important to explore what the summer effect is in areas with harsh winters compared to those with mild winters. Table 6 reports the summer effect on suicide for each of the three different latitude terciles for the youth age group, 19 year olds and 19–25 year olds. Column (3) shows that the youth summer effect is −1.01 and highly significant. The highest tercile youth summer effect coefficient is −0.75 and insignificant, and the middle tercile coefficient is −0.56 and marginally significant. We tested the equivalence of the estimated summer effect across terciles and were unable to reject the null of equal decreases.

Table 6
The summer effect by latitude.

	Highest tercile (1)	Middle tercile (2)	Lowest tercile (3)
Summer effect			
Youth	−0.75	−0.56*	−1.01***
	(0.43)	(0.27)	(0.34)
19 years old	1.23	1.34	0.57
	(0.86)	(1.00)	(0.80)
19–25 years old	0.14	0.73*	1.14***
	(0.48)	(0.41)	(0.23)
19–25 year old-youth	0.89	1.29	2.15

All regressions contain state and year fixed effects, but not demographic controls. Standard errors clustered at the state level are reported. Each regression is population weighted.
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

The summer effect for 19–25 year olds is positive in all terciles, and large and significant in the lowest tercile. The differential effect of the summer coefficient between youth and 19–25 year olds is reported in the last row. The differential effect is positive in all terciles, with the largest differential observed in the lowest tercile. If SAD explained the summer effect results in previous sections, the highest tercile in latitude would be driving the results, as the winters in the northern part of the US are more severe than the south. Instead, the youth summer effect coefficients are not significantly different across terciles, and the largest summer effect coefficient is observed in the lowest tercile. The fact that the lowest tercile has the strongest summer effect is potentially interesting in its own right, but beyond the scope of the analysis. Overall, Table 6 provides further evidence that SAD is not playing a significant role in the summer effect observed above.

When considering the role that SAD plays in the decrease in youth suicide over the summer, two important characteristics are analyzed in order to eliminate SAD as an explanation of the summer effect. First, females are significantly more prone to having SAD than males. In order for SAD to be a direct factor in the summer effect, it would have to be that the summer effect for females is noticeably larger than males. The opposite holds true though, and Table 5 shows that males are the gender driving the summer effect results.

A second component of SAD is that it is known to impact more northern areas, where winters are longer, than southern areas of the US. Table 6 shows the summer effect by latitude tercile and it is found that both the summer effect

[4] When regressions are run on specific age groups by gender, the summer effect is negative and significant for 17 and 18 year old males, but is insignificant for 19 year old males. The same general results are found with females, although the magnitude of the coefficients are smaller, consistent with the findings in Table 5.

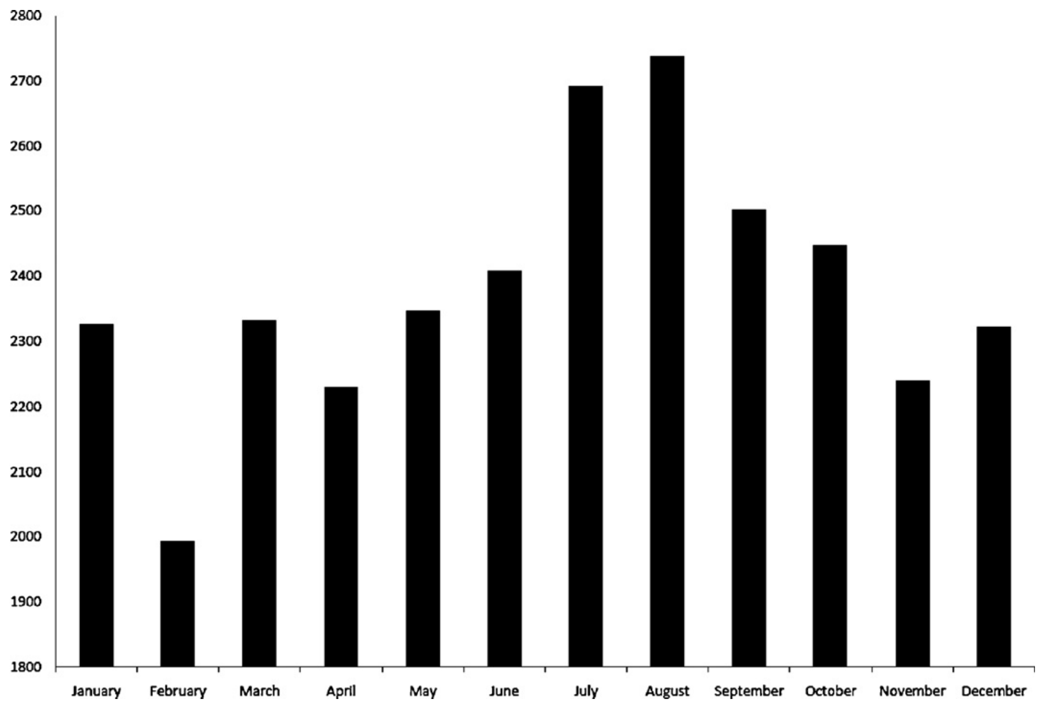

Fig. 5. Youth murder count by month, 1980–2004.

and the differential summer effect between the youth and 19–25 year olds are largest in southern part of the country. The symptoms of SAD predict that the differential summer effect should be the largest in the highest latitude tercile. These points, along with the fact that there is a sudden drop in suicide instead of gradual decrease over the spring convincingly rules out SAD as an explanation for the summer effect. This is not to say that SAD does not play a role in the suicide decision, however, these points show that the monthly suicide pattern coinciding with the academic calendar drowns out any effect from SAD that may exist.[5]

4.4. Seasonal patterns of youth murder and car accident deaths

The previous sections have shown that the summer effect has been stable over time and is not being driven by SAD. A final issue that is addressed is whether the summer effect observed in youth suicide is simply the seasonal pattern of unnatural youth deaths in general. To that end, this section analyzes the seasonal pattern of the two largest causes-of-death for youth, murder and car accidents, in order to confirm that the seasonal summer effect is unique to youth suicide.

Figs. 5 and 6 show the aggregate youth murder and car accident count by month from 1980 to 2004. Unlike the youth suicide patterns observed above, the youth murder and car accident deaths are highest in the summer months of July and August. The only months where there are significant drops in both causes-of-deaths are between August and September and then again in January and February. The fact that murders and car accidents increase in the summer is interesting in its own right, but beyond the scope of our analysis here. What can be observed from Figs. 5 and 6 is that the decrease in youth suicide during the summer months is not seen in youth murders and car accidents.

Before concluding that murders and car accidents do not have a negative summer effect, regressions are run to further confirm that murders and car accidents do not decrease during the summer months. Table 7 shows the regression results of Eq. (2) and similar to above, the population weighted regressions include state and year fixed

Table 7
The summer effect for murder and car accidents.

	Youth murder (1)	Youth car accident (2)	Youth suicide (3)
Summer	0.48**	3.62***	−0.83***
	(0.21)	(0.53)	(0.51)
Mean of dependent variable	6.77	18.41	11.66
State fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	15,300	15,300	15,300
R^2	0.44	0.60	0.19

All regressions contain state and year fixed effects, but not demographic controls. Standard errors are clustered at the state level. Each regression is population weighted.
** Significant at the 5% level.
*** Significant at the 1% level.

[5] Related to SAD, is another finding in the psychiatry literature that allergies may be related to suicide seasonality, as discussed in Postolache et al. (2005). However, while we document a sharp drop off in suicides during summer months for youth, they document seasonal peaks in spring and fall for both older and younger ages.

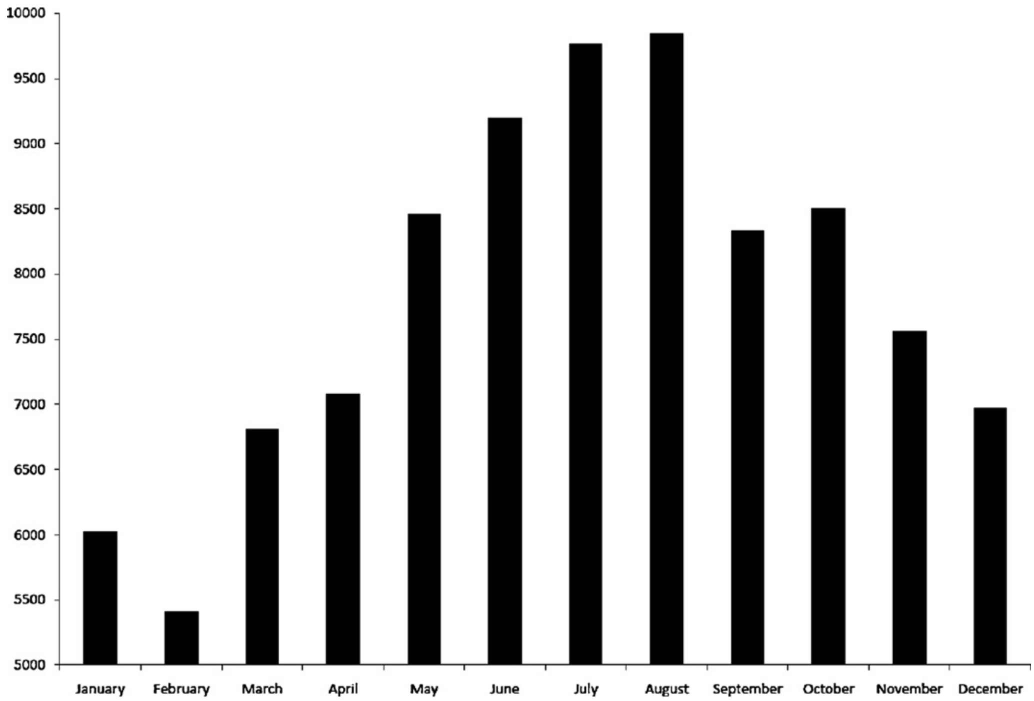

Fig. 6. Youth car accident count by month, 1980–2004.

effects and standard errors are clustered at the state level. Column (1) reports the results of the summer effect on the youth murder rate. Consistent with Fig. 5 above, the murder rate is significantly higher in the summer months compared to the rest of the year. Results for youth car accidents are reported in column (2) and show that in the summer months, the car accident death rate increases by 3.62 per 100,000. Both these results contrast the youth suicide results in column (3) showing that youth suicide decreases by 0.83 per 100,000 in the summer months. The results in Table 7 confirm the visual evidence in Figs. 5 and 6 and show that the seasonal pattern of youth murder and car accidents does not mimic the seasonal youth suicide pattern.

5. Conclusion

Recent high profile criminal cases in Massachusetts have anecdotally demonstrated the increased stress and decreased mental health that students can face as a result of being in school. Jacob and Lefgren (2003) begin to address some of these issues, finding a greater prevalence of violence when school is in session, which they attribute to increased negative social interactions. If negative social interactions are more likely when school is in session, then summer break could lead to a time period in which we expect the frequency of total negative social interactions to decline. This is in part because total social interactions are likely lower in summer months, and because youth have more latitude during the summer to select the peers with whom they spend their vacation months (this is similar to the relationship between mortality rates and activity discussed in Evans and Moore, in press).

Such explanations suggest some mechanisms which may be driving the significant decrease in youth suicides observed in summer months. This paper began by presenting a stylized fact showing that youth suicide appeared to follow the academic calendar closely, but the pattern ceased to persist into adulthood. Age specific graphs confirmed that the summer effect was isolated to those younger than 18. Regression results showed that the summer effect was robust to economic and social indicators and was isolated to high school aged individuals. The summer effect is stable over time, with yearly regressions showing that most years in the data have a significant summer effect for youth.

In order to eliminate seasonal affective disorder (SAD) as a possible explanation for the seasonal suicide pattern, gender specific regressions show that males are driving the results, while females are diagnosed with SAD more often. The effect of SAD on the seasonal pattern is minimized further when analyzing latitude tercile regressions and observing that the youth summer effect is statistically similar across terciles. A last robustness check shows that the summer decrease in suicides is not mimicked by youth murders or car accidents, the two most common causes-of-death for youth.

The results above not only show a distinct drop in suicide during the summer months, coinciding with a break from the stress of secondary school, but may help explain the recent rise in youth suicide over the past half century as the length of the school year increases and academic standards rise. The relationship we find between school months and suicide is not meant to take away from the noted benefits of schooling, but instead encourage those in the debate over school year length to recognize the challenges some students face in schooling, possibly from negative social interactions. So while Marcotte and Hansen (2010) discuss the potential benefits of lengthening the school year because of increased student performance, our findings suggest that the academic benefits of additional instructional days may come with the price of additional negative social interactions. It is unknown whether the timing of standardized testing affects the frequency or severity of the negative social interactions. Also unknown is whether longer school years or days would result in additional stress, or would simply spread the same stress out over more time. Lastly, it maybe that alternative school policies such as year-round schools lower the aggregate stress felt by students because of increased periods away from the negative social interactions causing the stress.

In order to more accurately diagnose what is leading to the increased suicide during school months and how suicide relates to both school calendar and assessment policies, further research is needed. To that end, in future research we intend to isolate the impact of schooling on suicide by exploiting changes in school calendars in the US and abroad, as well as variation in school policies which may minimize the increase in suicide during the school year.

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