Measuring the effects of COVID-19-related night curfews: Empirical evidence from Germany

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Abstract

We estimate the impact of local night curfews in Hesse, Germany, on the incidence of COVID-19 cases during the "second wave" of the COVID-19 pandemic in this state. We find no statistical evidence that the night curfews were effective in slowing down the spread of the pandemic.

1 Introduction

Since the end of 2019 a new coronavirus (SARSCoV-2 or COVID-19) spreads rapidly over the whole world and in early 2020 the WHO declared COVID-19 a pandemic.[1] After a slow down in the summer of 2020 the "second wave" of the pandemic hit Europe, including Germany, very hard. In order to limit virus transmission, German authorities declared a lockdown from November 2, 2020. Parts of that lockdown were several non-pharmaceutical interventions (NPIs). Besides the implementation of nationwide measures such as the limitation of gatherings and business closures some regions with very high infection rates additionally imposed night curfews. According to the German law system a careful assessment of the costs and benefits of an intervention is inevitable for its legal enforcement. While there was a broad consensus on most of the NPIs, the public debate about night curfews is highly controversial and still ongoing.[2]

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[1] https://www.who.int/docs/default-source/coronaviruse/transcripts/who-audio-emergencies-coronavirus-press-conference-full-and-final-11mar2020.pdf?sfvrsn=cb432bb3_2

[2] See for example: https://www.tagesschau.de/faktenfinder/ausgangssperren-corona-101.html

Similarly, there is also no consensus in the academic literature on whether night curfews present an appropriate measure to combat the pandemic. While some authors find that they are beneficial (Sharma et al., 2021) other studies are inconclusive (Dimeglio et al., 2021). However, typically multiple NPIs are imposed simulateneously which makes it challenging to isolate the effect of a single intervention (Soltesz et al., 2020).

In this study we examine the effectiveness of night curfews by taking advantage of regional and time variation in their implementation. Based on the federal system of Germany, NPIs were not imposed at the national level and even within federal states some NPIs were not imposed in all counties. In our analysis we use the federal state of Hesse as a case study to assess the effectiveness of night curfews from 9pm to 5am which were only introduced in some but not all counties during the second wave. Furthermore, they were implemented at different points in time and with different durations. This peculiarity allows us to identify a potential effect by using a control group when measuring the treatment effects. Our results suggest that the implementation of night curfews did not contribute to decreasing incidences. Note that some other NPIs were imposed simultaneously with a night curfew, e.g., limitation of the radius of movement or indoor individual sports. As we are not able to disentangle the effect of these different measures, our result - no significant effect - applies to the whole bundle of measures. In that respect our approach is a conservative one. We don't find an effect of the joint measures. This additionally supports the assumption that night curfews are not effective.

2 Data and Methodology

Our data set is built from two sources. Daily information on incidences (cumulative number of newly transmitted cases per 100,000 inhabitants over the past 7 days) at the county level were downloaded from the website of the Robert Koch Institute (RKI).[3] Hessischer Rundfunk, the regional public broadcasting agency collated information on local night curfews in Hesse consisting of start and end dates per county.[4] Our period of investigation starts on November 18, 2020 (when the RKI data start) and ends on February 28, 2021. This period roughly corresponds to the second wave in Hesse. There are 26 counties of which 15 had a night curfew during our observation period. The average duration of a night curfew was 28 days. Figure 1 and

[3] https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Daten/Fallzahlen_Archiv.html

[4] https://www.hessenschau.de/gesellschaft/hier-gelten-die-corona-ausgangssperren-in-hessen-,uebersicht-ausgangssperre-hessen-100.html. We would like to thank Jan Eggers for preparing the historical data.

Table 1 illustrates the timing of each night curfew and shows whether or not a curfew has been implemented.

Table 1: Night curfews in Hesse

county	start date	end date	duration in days
Bergstraße	21/12/2020	04/01/2021	14
Darmstadt	–	–	–
Darmstadt-Dieberg	22/12/2020	05/01/2021	14
Fulda	12/12/2020	05/02/2020	55
Frankfurt am Main	–	–	–
Gießen	13/12/2020	18/01/2021	36
Groß-Gerau	–	–	–
Hersfeld-Rotenburg	16/12/2020	18/01/2021	33
Hochtaunuskreis	–	–	–
Kassel	–	–	–
Lahn-Dill-Kreis	–	–	–
Limburg-Weilburg	12/12/2020	21/01/2021	40
Main-Kinzig-Kreis	11/12/2020	14/01/2021	34
Main-Taunus-Kreis	16/01/2021	27/01/2021	11
Marburg-Biedenkopf	–	–	–
Odenwaldkreis	15/12/2020	06/01/2021	22
Offenbach (Landkreis)	12/12/2020	06/01/2021	25
Offenbach (Stadt)	12/12/2020	07/01/2021	26
Rheingau-Taunus-Kreis	–	–	–
Schwalm-Eder-Kreis	17/12/2020	05/01/2021	19
Vogelbergkreis	17/12/2020	24/01/2021	38
Waldeck-Frankenberg	21/12/2020	04/01/2021	14
Waldeck-Frankenberg	08/01/2021	11/01/2021	3
Werra-Meißner-Kreis	–	–	–
Wetteraukreis	15/12/2020	05/01/2021	21
Wiesbaden	–	–	–

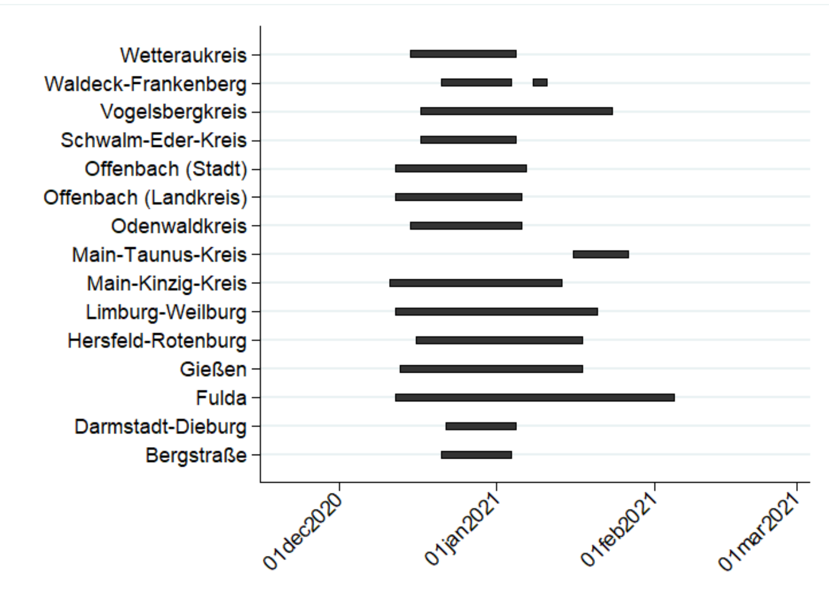

Figure 1: Night curfews in Hesse

To examine whether night curfews were effective in slowing down local incidences we apply a difference-in-differences approach. The idea is to asses whether incidences were smaller following a night curfew than they would have been in absence of it, by comparing the development of incidences in counties that have implemented night curfews with those that did not.

As with all NPIs aiming to reduce incidences there is a notable time delay until a measure's success can be evaluated. This is due to incubation period and delays in the recording and reporting of the incidence rates at the RKI website. The incubation period is assumed to be five days on average and the reporting lag adds two to nine days on top of that.[5] To account for the delay until night curfews actually unfold a measurable effect we move the start and end dates of each night curfew seven, ten and fourteen days ahead of their real dates and construct a binary variable "Effective curfew" which is equal to one during this period and zero otherwise. In formal terms:

$$\text{Effective curfew}_{i,t} = \begin{cases} 1, & \text{if } t \in [\text{Actual curfew start date}_i + 7/10/14 \text{ days}; \\ & \text{Actual curfew end date}_i + 7/10/14 \text{ days}] \\ 0, & \text{otherwise} \end{cases} \tag{1}$$

Furthermore, a major challenge in the identification of the effectiveness of night curfews comes from the fact that they have not been introduced randomly. On the contrary, night curfews have usually been implemented in counties in which incidence rates exceeded a threshold of 200 on at least three consecutive days.[6] In other words, action was taken in counties with already higher incidences. Thus, a simple comparison of the development of incidences in counties with and counties without night curfews may be misleading if incidences in counties that implemented night curfews would have also grown faster in absence of the night curfew. We control for this by additionally including two binary variables into the model. The first variable is equal to one from seven days before the curfew actually starts until the "Effective curfew" ends. Before and after it is equal to zero. We label this variable "Curfew - lead 2". In formal terms:[7]

[5]https://www.rki.de/DE/Content/Infekt/EpidBull/Archiv/2020/Ausgaben/17_20.pdf?__blob=publicationFile

[6]https://www.hessen.de/fuer-buerger/corona-hessen/das-hessische-eskalationskonzept-im-ampelsystem

[7]The results are robust when varying this lead to 3 or 5 days.

$$\text{Curfew - lead } 2_{i,t} = \begin{cases} 1, & \text{if } t \in [\text{Actual curfew start date}_i \text{ - 7 days;} \\ & \text{Effective curfew end date}_i] \\ 0, & \text{otherwise} \end{cases} \tag{2}$$

This variable captures the difference in the development of the incidences just before a night curfew was implemented. The second variable, which we label "Curfew - lead 1", is equal to one from the start of the actual curfew until the end of the effective curfew and is zero before and after that. It indicates whether there is a change in the difference in the development of incidences between counties that did implement night curfews and those that did not. Loosely speaking, it captures whether the dynamics of the pandemic differs in the two groups. In formal terms:

$$\text{Curfew - lead } 1_{i,t} = \begin{cases} 1, & \text{if } t \in [\text{Actual curfew start date}_i; \\ & \text{Effective curfew end date}_i] \\ 0, & \text{otherwise} \end{cases} \tag{3}$$

The variables are illustrated in Figure 2 which shows exemplary the infection process in two counties: Bergstrasse where a night curfew was implemented from December 22, 2020 until January 5, 2021 and Darmstadt whehre no night curfew was implemented.

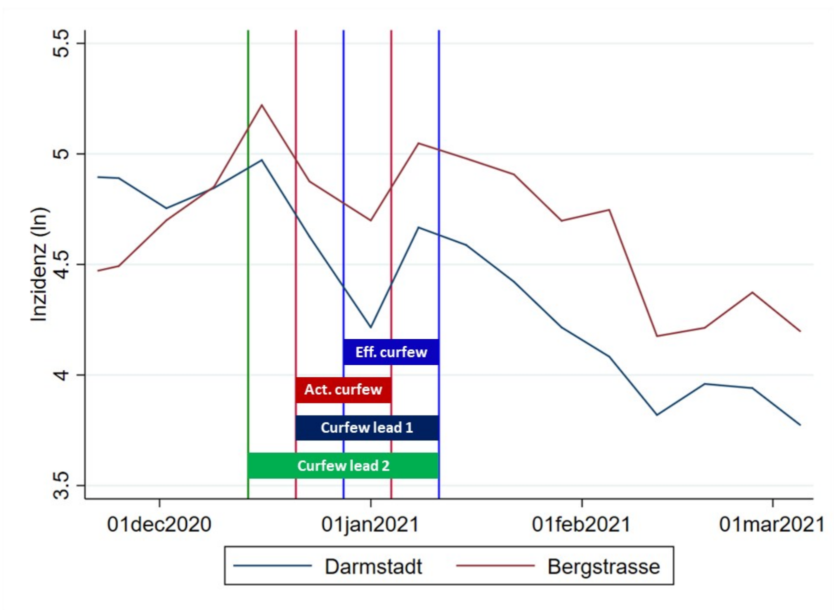

Figure 2: Exemplary infection process in two counties

The empirical model we estimate can be written as:

$$\begin{aligned} ln(I)_{i,t} &= \beta_1 \text{Effective curfew }_{i,t} \\ &+ \beta_2 \text{Curfew - lead } 1_{i,t} \\ &+ \beta_3 \text{Curfew - lead } 2_{i,t} \\ &+ \phi_i + \phi_t + \varepsilon_{i,t}, \end{aligned} \tag{4}$$

where I denotes the incidence in county i at day t. We use a logarithmic transformation of I in order to better approximate the exponential growth that is typically assumed for an infection process. β_1 is the coefficient of interest – the effect of the night curfew on the incidences I. We further include fixed effects for each day in our sample ϕ_i in order to control for general developments of the pandemic spread and for each county ϕ_i to control for time-invariant differences across counties that may effect the pandemic such as population density or demographic differences. In some models we also include interactions of county fixed effects with a linear time trend in order to allow for different general developments over time across counties.

3 Results

The results from the regression models described above are shown in Table 2. In Column (1) and (2) we assume a delay of seven days between the actual start of the curfew until it gets effective. In Column (2) we also add interactions of county fixed effects and a time trend. Analogously, we assume a delay of ten days in Columns (3) and (4) and fourteen days in Columns (5) and (6).

All models suggest that there has been a significant and large difference in the development of incidence rates in the week before the curfew got implemented. Depending on the model specification and assumptions about the delay until the curfew gets effective we find that the pandemic did spread 11% - 21% faster in counties that did implement a curfew 7 days later. However, the results further show no evidence that this difference in the pandemic spread changes between the start of the night curfew and the time until it gets effective due to the delay as indicated by the insignificant coefficients of "Curfew - lead 1" . This suggests the spread in the time before the night curfew gets effective was constant, which is important as it allows us to assess whether night curfews did affect the pandemic spread. However, although the coefficients for “Effective curfew” are negative across models they are never statistically significant. In other words, we find no statistically significant evidence that night curfews had an impact on the pandemic spread.

Table 2: Effects of night-time curfews on incidences in Hesse

	7 days delay		10 days delay		14 days delay	
	(1) ln(I)	(2) ln(I)	(3) ln(I)	(4) ln(I)	(5) ln(I)	(6) ln(I)
Effective curfew	-0.021	-0.052	-0.040	-0.062	-0.078	-0.077
	(0.064)	(0.054)	(0.069)	(0.060)	(0.071)	(0.061)
Curfew - lead 1	0.063	0.056	0.049	0.043	0.043	0.040
	(0.046)	(0.045)	(0.050)	(0.050)	(0.050)	(0.051)
Curfew - lead 2	0.182**	0.209***	0.164**	0.171***	0.138*	0.107**
	(0.066)	(0.043)	(0.069)	(0.041)	(0.074)	(0.046)
Day FE	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
County × Daily Time Trend FE	No	Yes	No	Yes	No	Yes
R^2	0.77	0.84	0.78	0.84	0.79	0.85
Obs.	2,314	2,314	2,236	2,236	2,132	2,132

Notes: Cluster-robust standard errors (clustered on county level) are presented in parentheses. Statistics are significant for $^{***}p < 1\%$, $^{**}p < 5\%$, $^{*}p < 10\%$. The estimations are performed by using the *reghdfe* command in Stata. The data set is available at https://www.uni-giessen.de/resolveuid/eb4b79005ae54e8da281694e1bed1809

4 Conclusion

We estimate the impact of local night curfews in Hesse, Germany, on the incidence of COVID-19 cases during the "second wave" of the COVID-19 pandemic in this state. While our data set is limited to the federal state of Hesse, the analysis is taking advantage of regional and time variation in the implementation of night curfews. Thus, we are able to overcome potential statistical problems, that are related to estimations of benefits of NPIs. Our results suggest that night curfews are not an effective measure to limit virus transmission when various other NPIs are already imposed.

However, these results are preliminary and we will try to expand our data set to all of Germany. Further research should also check the robustness of our results, when using different variables to measure the infection process, e.g., the R number.

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