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Holy Days, Lost Days?

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Holy Days, Lost Days? *

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Abstract

Do public holidays affect economic output? In Germany, strict Sunday trading restrictions create a natural experiment. When public holidays fall on Sundays, they typically do not impose additional constraints on business activity. I exploit this institutional feature to identify the economic cost of a lost workday using variation across states and years. Based on monthly manufacturing data and a stacked event study design, I find that weekday public holidays lead to modest but statistically significant reductions in output. Extrapolating the estimates implies annual GDP losses between 0.055% and 0.28%, depending on whether the effect is assumed to apply only to manufacturing or to the entire economy.

Keywords: Public holidays, Labor supply, Natural experiment, Germany
JEL codes: E23, J22, H24, H75

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1 Introduction

In 2023, the Danish government abolished the public holiday Store Bededag (Great Prayer Day) to help fund defense spending, citing the need to boost labor supply. Nearly thirty years earlier, Germany eliminated Buß- und Bettag (Day of Repentance and Prayer) in most states to support long-term care insurance. In France, following the deadly 2003 heatwave, Lundi de Pentecôte (Pentecost Monday) was controversially reclassified as a working day to finance long-term care. Each of these decisions triggered fierce public debates over the costs and benefits of public holidays — both economic and symbolic. Do such days meaningfully reduce productivity, or are they culturally valuable holidays with limited macroeconomic cost?

This paper provides a within-country, quasi-experimental estimate of the short-run output cost of paid national holidays. Specifically, I study a setting in which some public holidays are, by design or coincidence, economically irrelevant. In Germany, nearly all commercial activity ceases both on Sundays and public holidays due to stringent legal restrictions on work, enshrined not only in statutory law but also in the constitution.[1] As a result, when a public holiday falls on a Sunday, it does not generate additional reductions in production or consumption.

Since many holidays rotate across weekdays and are not uniformly observed across federal states, this creates quasi-random variation in the "effective" number of holidays.[2] I exploit this variation to estimate how manufacturing revenues respond when a holiday falls on a Sunday. If a holiday falling on a Sunday produces no output drop, but the same holiday on a weekday does, the difference identifies the economic cost of the day off. This design echoes the logic in Montero and Yang (2022), though the variation here arises from institutional overlap (Sunday rest $\times$ public holiday), not the agricultural cycle.

A long-standing literature emphasizes how institutions shape aggregate labor supply and productivity. For example, Alesina, Glaeser, and Sacerdote (2005) attribute cross-country differences in working hours to social norms and institutions, and Prescott (2004) highlight the role of labor-income taxation. More recent work examines short-run variation in time away from work. Lee, Kawaguchi, and Hamermesh (2012) show that mandated reductions in hours are largely reallocated to leisure, while Montero and Yang (2022) document persistent income losses from religious festivals overlapping with harvest periods.

[1]Sunday and holiday rest is protected under Article 140 of the Basic Law (Germany's constitution). This principle is implemented through the Working Hours Act (Arbeitszeitgesetz, §9), which prohibits most forms of work both on Sundays and public holidays, and the Continued Remuneration Act (Entgeltfortzahlungsgesetz, §2), which mandates full pay for employees on these non-working days. These legal guarantees stand in stark contrast to the United States, where Sundays are generally unrestricted and public holidays do not require (private) employers to provide paid leave.

[2]Appendix Figure A.1 shows that moving public holidays are approximately evenly distributed across weekdays, supporting the assumption of quasi-random timing.

A related set of studies focuses on how holiday timing affects economic activity in consumer and labor markets. For instance, Basker (2005) shows that a longer U.S. Christmas shopping season raises retail sales, Urbatsch (2013) finds that earlier Thanksgivings increase November employment, and Strielkowski (2013) discusses the commercial potential of culturally driven holidays such as Halloween. These papers highlight the sensitivity of output and employment to the calendar but do not provide causal estimates of the productivity cost of paid holidays.

My paper is most closely related to empirical studies that use policy variation to assess how working-time regulations affect productivity and health. Danchev and Genakos (2015) analyze liberalizations of Sunday trading laws, Paul (2015) and Bossler and Oberfichtner (2017) examine employment effects of deregulating shop opening hours in German retail, and Prodromidis, Karlsson, and Kühnle (2025) study the impact of working-hour caps on workers' health in Sweden. I extend this literature by quasi-experimentally identifying the output cost of paid holidays within one country using an explicit inactive-holiday counterfactual built into German law.

Closest in spirit, Rosso and Wagner (2022) exploit weekend-falling holidays in a global panel (2000–2019) and estimate a working-day elasticity of GDP around 0.2, implying roughly 0.08% lower annual GDP per holiday, with stronger effects in manufacturing. My study complements theirs by (i) leveraging Germany's constitutionally enforced Sunday rest to define inactive holidays; (ii) using monthly state-level manufacturing outcomes and hours to link inputs and outputs; and (iii) providing stacked event-study diagnostics. Consistent with their macro elasticity, my conservative aggregation implies a whole-economy effect of about 0.055% of GDP per holiday, with an upper bound of ~0.28%.

To study the impact of public holidays on productivity, I combine three pieces of evidence. First, I use monthly state-level data from the monthly survey of manufacturing establishments by the German Federal Statistical Office (2023) to estimate how Sunday holidays affect real per capita revenue and working hours. Second, I validate these estimates through a stacked event-study that compares outcomes across holiday-year cohorts, offering transparent pre-trend diagnostics. Finally, I simulate the aggregate macroeconomic effect using posterior draws from the baseline estimates and Germany's GDP composition. Together, the results suggest that holidays reduce economic activity modestly but measurably, with estimated annual output effects of up to 0.3%, depending on assumptions about sectoral incidence.

2 Data and Empirical Strategy

2.1 Data

To implement my analysis, I rely on monthly panel data from the Cost Structure Survey of Manufacturing Establishments conducted by the German Federal Statistical Office Federal Statistical Office (2023), covering all 16 federal states from 2005 to 2019. The survey provides establishment-level data on revenue, employment, and working hours, aggregated to the state-month level. I focus on two primary outcome variables: real revenue per employee and working hours per employee.

I normalize both measures by the number of employees for three reasons. First, German states differ substantially in size and industrial structure, leading to large cross-sectional differences in total manufacturing employment. Per-employee normalization removes this mechanical source of variation, ensuring that estimated effects reflect changes in production *intensity* rather than scale. Second, the quasi-experimental variation in this study—whether a public holiday falls on a Sunday versus a weekday—primarily affects the *intensive margin* of production (revenue per worker, hours per worker) rather than the extensive margin (total employment). Employment adjusts slowly over time and is unlikely to respond to the day-of-week on which a single holiday falls within a given month. Per-employee measures directly capture this intensive margin of adjustment. Third, the GDP simulation in Section 5 scales manufacturing effects to the economy by assuming proportional impacts on output per worker across sectors. Using per-employee measures ensures conceptual alignment between the estimated effects and the GDP extrapolation. Robustness checks using total (unadjusted) outcomes confirm that results are nearly identical regardless of normalization (coefficients differ by less than 2%), reflecting the stability of employment within state-month-year cells.

Manufacturing outcomes in this paper are measured as real revenue (gross output) per employee rather than value added, because monthly state-level value-added data are not available in German official statistics. The GDP simulation therefore assumes that percentage changes in manufacturing revenue induced by holiday timing translate proportionally into percentage changes in manufacturing value added, i.e. $\Delta \log(\text{Revenue}) \approx \Delta \log(\text{Value Added})$. This assumption is standard when shocks primarily affect labor input rather than intermediate input intensity. If intermediate input shares remain approximately constant at the monthly horizon, the gross-output elasticity closely tracks the value-added elasticity. To the extent that firms partially adjust intermediate inputs when labor input falls, this mapping would overstate value-added responses, implying that the resulting GDP effects should be interpreted as an upper bound.

Nominal manufacturing revenue is deflated using Germany's national Consumer Price Index (CPI), normalized to 2015 = 100, to obtain real revenue per employee in constant prices. I use the annual CPI rather than monthly CPI for two reasons. First, the identifying variation operates at the year-to-year level through changes in the weekday on which a given holiday falls, rather than through within-year price movements. Second, annual CPI avoids introducing spurious correlation between the deflator and the holiday timing variables, which vary within the year. CPI is used instead of a manufacturing-specific producer price index because manufacturing output is ultimately sold to final consumers or other sectors, making the general price level the relevant benchmark for real revenue. Manufacturing PPIs are not available at the required state-month granularity.

Public holiday dates are compiled from official state calendars and mapped to their weekday occurrence and state-level observance. In Germany, several holidays occur on fixed calendar dates (e.g., the Reunification Day on October 3rd), causing them to rotate across weekdays over time. Some (religious) holidays are celebrated only in a subset of states over the whole sample period, such as *Allerheiligen* (All Saints' Day), *Heilige Drei Könige* (Epiphany), or *Mariä Himmelfahrt* (Assumption of Mary, observed only in Catholic districts of Bavaria), providing additional cross-sectional variation. Appendix A.1 provides summary statistics for the main variables and documents the distribution of holiday timing that generates the identifying variation.

2.2 Empirical strategy

Baseline specification. The key explanatory variables are the number of public holidays in a given month that fall on a Sunday (*SundayHolidays*) and the total number of public holidays that month (*TotalHolidays*). The estimating equation is:

$$\log(y_{smt}) = \beta \cdot \text{SundayHolidays}_{smt} + \delta \cdot \text{TotalHolidays}_{smt} + \alpha_s + \gamma_t + \mu_m + \varepsilon_{smt}, \qquad (1)$$

where y_{smt} denotes either log real revenue per employee or log working hours per employee in state s, calendar month m, and year t. The model includes fixed effects for states (α_s), calendar years (γ_t), and calendar months (μ_m), which control for persistent differences across states, common national trends, and seasonal patterns. Standard errors are multi-way clustered at the state-year-month level to account for arbitrary correlation within these dimensions.

The coefficient on *SundayHolidays* (β) is the main parameter of interest. A positive estimate indicates that months with more "inactive" holidays—holidays falling on a Sunday that do not reduce weekday production—are associated with higher output per worker. This captures the implicit gain from preserving a workday. Including *TotalHolidays* (δ) as a control separates this effect from the general disruptive impact of holidays on production, most of which fall on weekdays. Because Sunday holidays are a subset of total holidays, months with more holidays overall are more likely to have Sunday holidays. In the sample, the two variables exhibit a correlation of 0.32. The *TotalHolidays* coefficient absorbs the (negative) direct effect of weekday holidays on output, allowing β to identify the relative gain when a holiday falls on a Sunday rather than a weekday.[3]

One potential concern is that firms know the holiday calendar years in advance and may adjust production schedules, inventory, or staffing preemptively. However, such anticipation would bias the estimates toward zero by allowing firms to smooth production across weeks or months within the year. The estimates therefore represent a conservative lower bound on the disruption that would occur if holidays were unexpected. The fact that we observe measurable output losses despite this anticipation suggests meaningful rigidities in production smoothing.

Several German states introduced new public holidays in 2018–2019, including the expansion of Reformationstag to four northern states and the introduction of Weltfrauentag (Berlin) and Weltkindertag (Thuringia). To ensure that these late-sample institutional changes do not drive the results, I conduct a robustness check excluding 2018–2019. As documented in Appendix A.4, the estimates are virtually unchanged—indeed, slightly larger—when these years are excluded, confirming that the findings are not sensitive to these recent holiday introductions.

2.2.1 Stacked Event Study Design

To validate the identifying assumptions and assess dynamic effects, I implement a stacked event-study that exploits the quasi-random timing of state and national holidays falling on Sundays. The design compares economic outcomes across different event years within the same calendar month and state, isolating the moment when a specific holiday no longer reduces output because it falls on a Sunday.

The event-time dimension is naturally annual because treatment status is determined at the year level: whether a given holiday falls on a Sunday or a weekday is realized once per year and remains constant for all months of that year. There is no within-year treatment variation to exploit. Monthly outcomes are observed at higher frequency because production data are available monthly, but identification comes from comparing the same calendar month across different years in which the weekday realization of holidays differs. For example, October output in a year where a public holiday falls on a Sunday is compared to October output in

[3] All regressions in this article are computed using R and the *tidyverse* package ecosystem (Wickham et al. (2019)) as well as *fixest* (Bergé (2018)) and *modelsummary* (Arel-Bundock (2022)).

years where the same holiday falls on a weekday.

The analysis proceeds in three steps. First, I identify all holidays that rotate across weekdays and are observed in at least one federal state in multiple years. For each holiday–state–year combination in which the holiday falls on a Sunday, I define a treatment cohort. A cohort is thus a holiday–state pair tracked over time, indexed by the event year when that holiday falls on a Sunday. Each cohort contributes observations for multiple years before and after the event year. Cohort fixed effects absorb all time-invariant differences across holidays and states, while calendar month fixed effects ensure that comparisons are always made within the same calendar month.

Second, I construct a balanced panel of ± 4 years around each cohort's treatment year. For each observation in this panel, I generate an event-time variable $k = \text{year} - \text{event\_year}$ and a binary indicator *HolidayMonth*, which equals one in the month the holiday typically occurs and zero otherwise. This isolates variation within the holiday's calendar month across time.

Third, I estimate the following specification:

$$\log(y_{smct}) = \sum_{k=-4,\, k\neq -1}^{+4} \beta_k \cdot \mathbf{1}\{\text{period} = k\} \times \text{HolidayMonth}_{smct} + \alpha_s + \mu_m + \lambda_k + \delta_c + \varepsilon_{smct}, \quad (2)$$

where $\log(y_{smct})$ denotes log real revenue per capita in state s, month m, and cohort c at event time k. The model includes fixed effects for states (α_s), calendar months (μ_m), event-time (λ_k), and event cohorts (δ_c), and clusters standard errors at the event cohort level.

This setup isolates the effect of "losing" a holiday within a given calendar month, while controlling for seasonality, national economic cycles, and holiday-specific shocks. The coefficients β_k trace out the dynamic response of output in the holiday month relative to the reference year ($k = -1$), the last year before the holiday falls on a Sunday. Importantly, coefficients for pre-treatment years ($k < 0$) provide a transparent test of the parallel trends assumption, while β_0 captures the immediate revenue effect of the holiday becoming economically inactive.

2.3 Posterior Simulation

To assess the macroeconomic significance of the estimated effects, I simulate from the posterior distribution of the coefficient $\hat{\beta}$ on *SundayHolidays* from the main specification. I draw 20,000 samples from a normal distribution with mean and standard error corresponding to the point estimate and robust standard error of the baseline regression. Each draw is converted into an annualized percentage change by dividing the monthly effect by 12. I report results under two assumptions. First, I assume the treatment effect applies uniformly across the entire economy. Second, I restrict the effect to apply only to the manufacturing sector, since the estimates are derived from revenue and labor input in that sector. This yields a conservative lower bound on the output effect, concentrating only on the 20% of German GDP for which the effect is directly identified. In addition I scale the effect by German GDP in 2023 to obtain an estimate for output loss in Germany in euros.

3 Results

Table 1: Regression for the Effects of Sunday Holidays on Manufacturing Revenue and Working Hours

	(1) **Log Revenue per Employee**	(2) **Log Revenue per Employee**	(3) **Log Working Hours per Employee**	(4) **Log Working Hours per Employee**
Sunday Holidays	0.024	0.032**	0.016	0.026***
	(0.014)	(0.012)	(0.011)	(0.006)
Total Holidays		-0.028***		-0.035***
		(0.004)		(0.002)
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Calender Month FE	Yes	Yes	Yes	Yes
N	2880	2880	2880	2880
R^2	0.928	0.929	0.683	0.751

Notes: Each column reports coefficients from fixed-effects regressions using monthly state-level data from the German manufacturing sector (2005–2019). The dependent variable is log real manufacturing revenue per employee in columns (1)–(2), and log total working hours per employee in columns (3)–(4). The key explanatory variable, Sunday Holidays, counts the number of public holidays in a given month that fall on a Sunday. Total Holidays captures the total number of holidays (weekday and Sunday) in that month. All models include fixed effects for calendar month, calendar year, and state. Standard errors are multi-way clustered by state, calendar year, and calendar month and reported in parentheses. Significance levels: p<0.1 (*), p<0.05 (**), p<0.01 (***).

Table 1 shows the results of fixed-effects regressions estimating the impact of Sunday holidays on manufacturing output based on equation 1. Columns (1) and (2) show results for log revenue per employee as the outcome, while columns (3) and (4) present results for log total working hours. In both cases, the coefficient on *SundayHolidays* is positive, indicating higher output and labor input when holidays fall on Sundays and thus do not interrupt weekday production. The effect becomes larger and statistically significant once Total Holidays is included as a control (columns 2 and 4), confirming that weekday holidays also depress activity. This pattern is expected: months with several holidays both increase the probability that one falls on a

Sunday and reduce output through weekday holidays, so including *TotalHolidays* separates the general holiday effect from the specific "inactive holiday" effect. The magnitude is similar across outcomes: Sunday holidays raise revenue by about 3% and working hours by 2.6% in the fully specified models, suggesting these gains reflect real preservation of workdays.

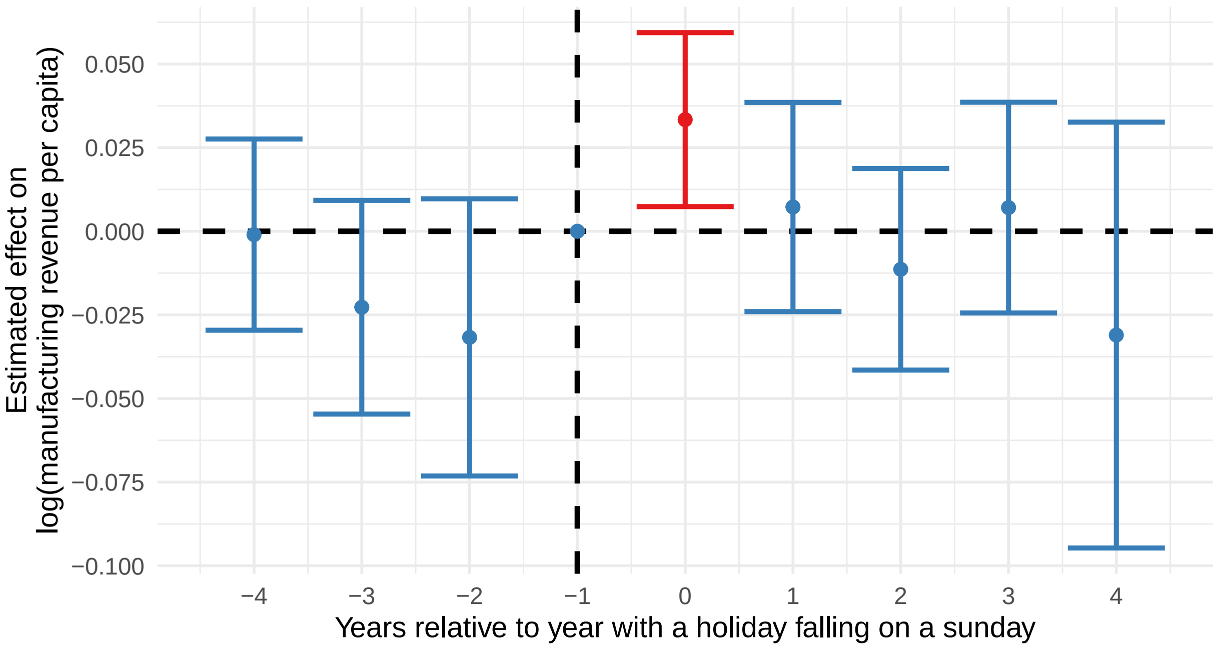
The *TotalHolidays* coefficient is larger in absolute value than the *SundayHolidays* coefficient because it captures the direct disruptive effect of weekday holidays, which constitute the vast majority of holiday occurrences. Since Sunday holidays are a subset of total holidays, the *TotalHolidays* coefficient reflects the average disruption from all holidays (mostly weekday), while *SundayHolidays* identifies the relative gain from avoiding this disruption when a holiday coincidentally falls on Sunday. The 3.2% monthly revenue effect from Sunday holidays is smaller than the mechanical benchmark of 4.65% (1 workday out of approximately 21.5 workdays per month), suggesting partial intra-month reallocation: firms may compensate for anticipated disruptions through overtime on other days, shift adjustments, or production rescheduling within the same month.

To interpret these estimates in terms of macroeconomic relevance, consider the coefficient on Sunday Holidays from column (2), which implies that each additional holiday falling on a Sunday raises monthly revenue per employee by 3.2%. Annualizing this monthly effect yields an approximate yearly gain of 0.27% in manufacturing output per employee, assuming a uniform distribution of such holidays throughout the year. A similar calculation for working hours, using the 2.6% coefficient from column (4), implies an annual increase of roughly 0.22% in total hours worked.

Figure 1 presents results from a stacked event-study design based on equation 2 to validate the results from table 1. The specification compares manufacturing revenue in the month a holiday occurs across ± 4 years around the year it falls on a sunday, controlling for state, calendar-month, and holiday-type-event-year cohort. The coefficient at event time 0 captures the immediate shift in output when a holiday falls on a Sunday.

The estimated effect at event time 0 is positive and statistically significant and falls in the same range suggested by the estimates in Table 1. Notably, the point estimate also suggests a roughly 3% increase in monthly output for years with a Sunday holiday. Pre-treatment coefficients are small and not significantly different from zero, supporting the assumption of parallel trends. The slight dip at event time −2 likely reflects holidays falling on Fridays, which are more disruptive to production compared to the reference year (−1) which corresponds to Saturday holidays. Saturdays are already partial non-working days in many firms, thus attenuating the baseline effect. This weekday pattern helps explain why some pre-treatment coefficients trend slightly negative, even though they are not statistically significant. Post-treatment effects remain modest and statistically indistinct, consistent with a one-time gain from avoiding the

Figure 1: Stacked Event Study for the Effect of a Sunday Holiday



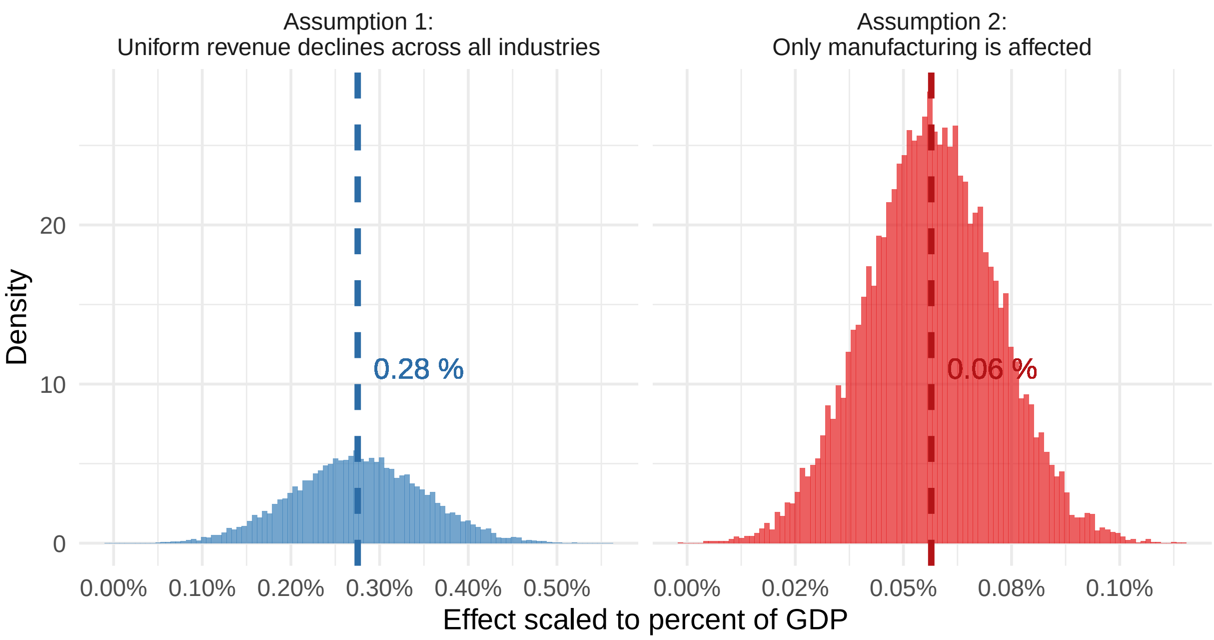
Notes: This figure shows estimated effects of a holiday falling on a Sunday on log manufacturing revenue per capita, using a stacked event-study design. Each point represents the estimated difference in revenue in the holiday month, relative to the year immediately before the holiday first coincides with a Sunday (event time = −1). The red point at event time 0 captures the immediate effect of the holiday becoming economically inactive. Pre-treatment estimates are close to zero, supporting the parallel trends assumption. Error bars indicate 95% confidence intervals, with standard errors clustered at the event cohort level.

temporary loss of a working day rather than any lasting trend.

4 Macroeconomic Relevance: Posterior Simulation

To translate the estimated monthly revenue effects into macroeconomic terms, I simulate the implied annual GDP gain from avoiding a single working-day holiday. Figure 2 shows the distribution of GDP effects under two alternative assumptions. The first assumes the estimated revenue effect applies uniformly across all sectors of the economy, while the second restricts the effect to manufacturing alone. These two assumptions provide upper and lower bounds for the likely aggregate effect: the full-economy assumption likely overstates the true impact by applying manufacturing-based estimates to all sectors, while the manufacturing-only assumption likely understates it by ignoring that many service sectors (retail, hospitality, entertainment) are directly constrained by Sunday and holiday regulations, not merely indirectly affected through manufacturing linkages. Both scenarios are based on 20,000 posterior draws from the main estimate in column (2) of Table 1.

Figure 2: Posterior Simulation for the Implied Effect on GDP



Notes: This figure shows simulated GDP effects based on 20,000 posterior draws of the estimated revenue gain from a holiday falling on a Sunday. Under Assumption 1 (left panel), the effect is extrapolated to the entire economy, assuming revenue effects are uniform across sectors. Under Assumption 2 (right panel), the effect is restricted to the manufacturing sector, which accounts for roughly 20% of GDP. Vertical dashed lines indicate posterior medians. The median estimated gain is 0.28% of GDP under Assumption 1 and 0.06% of GDP under Assumption 2.

Under the assumption that revenue losses are evenly distributed across all sectors, the median gain amounts to roughly 11.3 billion euros, or 0.28 % of GDP. If the effect is limited to manufacturing (which comprises 20 % of GDP), the median gain drops to about 2.3 billion euros, or 0.055 % of GDP. The simulated distributions are relatively narrow: even the upper bound of the 90 % credible interval does not exceed €17.7 billion in the full-economy case or €3.6 billion in the manufacturing-only case.

To better gauge the economic plausibility of large effects, I examine posterior probabilities for a range of GDP thresholds. Under the uniform-impact assumption, there is a 95 % probability the gain exceeds 0.1 % of GDP, but only a 1 % probability it exceeds 0.5 %. The bulk of the posterior mass (over 75 %) lies between 0.2 % and 0.4 % of GDP. In contrast, under the manufacturing-only scenario, the effect is very likely below 0.1 % of GDP, with virtually zero probability of reaching 0.2 %. These results suggest that the cost of lost working days is economically meaningful but bounded. It is rarely large enough to exceed 0.3 % of GDP, yet robustly different from zero.

Compared to the mechanical benchmark of 0.4% ($\approx$ 1/250 workdays), the 0.28% upper bound indicates partial intra-month reallocation of activity through overtime, shift smoothing, or other forms of intertemporal adjustment. The manufacturing-only estimate (0.055%) is close to the benchmark implied if only manufacturing were affected ($\approx$ 0.08%). Appendix A.3 shows that a positive holiday timing effect is also visible (though not statistically significant) in a broader national business activity index covering sectors B–N, consistent with the manufacturing-based estimates while exhibiting the expected attenuation due to broader sectoral coverage and national-level aggregation.[4]

5 Conclusion

This paper estimates the manufacturing output loss in German states when holidays fall on Sundays versus weekdays. The results show that Sunday holidays are associated with a roughly 3% increase in monthly revenue per employee, consistent with the idea that avoiding a workday disruption yields modest but measurable gains. Scaling this effect to the national level suggests that removing one public holiday could raise annual GDP by up to 0.3%, depending on whether the effect is limited to manufacturing or assumed to generalize across sectors.

While these results point to a real output cost of public holidays, they should not necessarily be interpreted as a general argument for abolishing them. First, the analysis focuses solely on short-run production effects and does not capture potential long-run benefits of rest days, such as improved health, well-being, or social connectedness (e.g., Merz and Osberg (2006)). Second, while the estimates are directly identified from manufacturing data, many service sectors

[4]The national coefficient (+0.008) implies an annualized effect of approximately 0.07% for sectors covering 60% of the economy. Extrapolating to the full economy yields roughly 0.11% of GDP, reassuringly between our manufacturing-only lower bound (0.055%) and full-economy upper bound (0.28%). The intermediate magnitude suggests that service sectors are affected by holiday timing, but less intensively than manufacturing; this attenuation is consistent with greater intertemporal flexibility and weaker regulatory constraints in many services, as well as offsetting demand effects in sectors such as hospitality and leisure, where holidays may even raise revenue despite reducing weekday labor input.

(retail, hospitality, entertainment) face similar constraints from Sunday and holiday regulations, suggesting the effects may extend beyond manufacturing. However, other services may have greater scheduling flexibility. The output loss from a holiday is real, but likely modest enough to leave room for broader social considerations in policy design.

References

Alesina, Alberto, Edward Glaeser, and Bruce Sacerdote (2005). "Work and leisure in the United States and Europe: Why so different?" In: *NBER Macroeconomics Annual* 20, pp. 1–64.

Arel-Bundock, Vincent (2022). "modelsummary: Data and Model Summaries in R". In: *Journal of Statistical Software* 103(1), pp. 1–23. DOI: 10.18637/jss.v103.i01.

Basker, Emek (2005). "'Twas four weeks before Christmas: Retail sales and the length of the Christmas shopping season". In: *Economics Letters* 89(3), pp. 317–322.

Bergé, Laurent (2018). "Efficient estimation of maximum likelihood models with multiple fixed-effects: the R package FENmlm". In: *CREA Discussion Papers*(13).

Bossler, Mario and Michael Oberfichtner (2017). "The employment effect of deregulating shopping hours: Evidence from German food retailing". In: *Economic Inquiry* 55(2), pp. 757–777. DOI: 10.1111/ecin.12394.

Danchev, Stoil and Christos Genakos (2015). "You're banned! The impact of Sunday trading bans on employment and output". In: *IMF Economic Review* 63(3), pp. 575–602.

Federal Statistical Office (2023). *Cost Structure Survey of Manufacturing Establishments*. Wiesbaden: Federal Statistical Office (Destatis). URL: https://www.destatis.de/EN.

Lee, Jungmin, Daiji Kawaguchi, and Daniel S Hamermesh (2012). "Aggregate impacts of a gift of time". In: *American Economic Review* 102(3), pp. 612–616.

Merz, Joachim and Lars Osberg (2006). *Keeping in Touch: A Benefit of Public Holidays*. IZA Discussion Paper 2089. Bonn: IZA Institute of Labor Economics.

Montero, Eduardo and Dean Yang (2022). "Religious Festivals and Economic Development: Evidence from the Timing of Mexican Saint Day Festivals". In: *American Economic Review* 112(10), pp. 3176–3214.

Paul, Annemarie (2015). "After work shopping? Employment effects of a deregulation of shop opening hours in the German retail sector". In: *European Economic Review* 80(C), pp. 329–353.

Prescott, Edward C (2004). "Why do Americans work so much more than Europeans?" In: *Federal Reserve Bank of Minneapolis Quarterly Review* 28(1), pp. 2–13.

Prodromidis, Nikolaos, Martin Karlsson, and Daniel Kühnle (2025). *Working Hours and Workers' Health: Evidence from a National Experiment in Sweden*. IZA Discussion Paper 17707. IZA Institute of Labor Economics.

Rosso, Lucas and Rodrigo Wagner (2022). “Causal Effect of Public Holidays on Economic Growth”. SSRN Working Paper No. 3845129, version: Nov 30, 2022. URL: https://ssrn.com/abstract=3845129.

Strielkowski, Wadim (2013). “Economic and business potential of public holidays: a case of Halloween”. In: *Journal of Advanced Research in Management* 4(8), pp. 99–105.

Urbatsch, Robert (2013). “Employment effects of Thanksgiving timing”. In: *Economics Letters* 119(1), pp. 42–44.

Wickham, Hadley et al. (2019). “Welcome to the tidyverse”. In: *Journal of Open Source Software* 4(43), p. 1686.

Appendix

A.1 Descriptive Statistics

This section provides summary statistics on the key variables used in the analysis and documents the identifying variation in holiday timing that underlies the estimation strategy.

Table A.1: Summary Statistics: State-Month Panel (2005–2019)

Variable	Mean	SD	Min	Max
Revenue per employee (EUR)	31,448	15,978	14,307	109,719
Hours per employee (monthly)	130.4	9.0	95.6	156.7
Total holidays in month	0.88	1.01	0	4
Sunday holidays in month	0.08	0.28	0	2

Notes: N = 2,880 state-month observations (16 states $\times$ 15 years $\times$ 12 months). Revenue per employee: real manufacturing revenue divided by number of employees, deflated by CPI (2020 = 100). Hours per employee: total manufacturing hours worked divided by number of employees. Sunday holidays: public holidays falling on Sunday, which avoid weekday production losses under German Sunday rest laws.

Table A.1 reports summary statistics for the main outcome and treatment variables. The average manufacturing establishment generates approximately EUR 31,400 in real revenue per employee per month, with substantial variation across states (SD = 15,978). Monthly working hours average 130 per employee. On average, state-months contain 0.88 public holidays, of which 0.08 fall on Sunday. This low mean reflects that only about 8% of holidays coincidentally fall on Sundays in any given year.

Table A.2: Distribution of Public Holidays by Calendar Month (2005–2019)

Month	Total	Sunday	Weekday	% Sunday
January	285	57	228	20.0
March	129	0	129	0.0
April	352	0	352	0.0
May	638	48	590	7.5
June	172	0	172	0.0
August	15	1	14	6.7
October	334	21	313	6.3
November	90	10	80	11.1
December	480	64	416	13.3
Total	2,496	201	2,295	8.1

Notes: Counts of public holiday occurrences across all 16 German states over the 15-year sample period. Excludes Ostersonntag (Easter Sunday) and Pfingstsonntag (Whit Sunday), which always fall on Sunday by definition. Months with zero holidays (February, July, September) omitted. "Sunday" = holiday falls on Sunday (production loss avoided under Sunday rest laws); "Weekday" = holiday falls Monday–Saturday (production loss incurred).

Table A.2 documents the distribution of holidays across calendar months. The identifying variation comes from fixed-date holidays that rotate through weekdays over the calendar cycle: New Year's Day (January 1), Labor Day (May 1), German Unity Day (October 3), and Christmas (December 25–26). Moving holidays tied to Easter (Good Friday, Easter Monday, Ascension, Whit Monday, Corpus Christi) always fall on specific weekdays by definition and contribute no Sunday variation—hence the zero values for March, April, and June. Of 2,496 total holiday occurrences in the sample, 201 (8.1%) fall on Sunday.

Table A.3: Public Holiday Counts by Federal State (2005–2019)

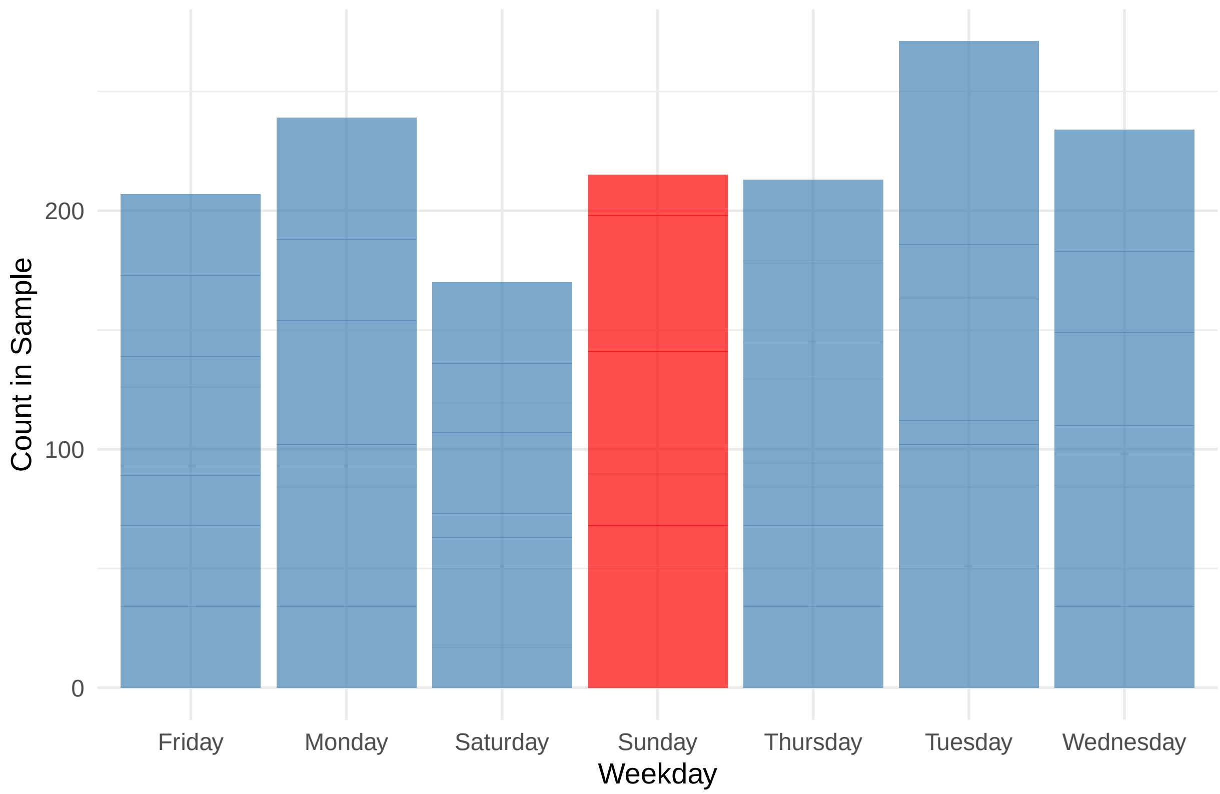
State	Mean holidays/year	Min	Max
BW, BY, SL	12.1	12	13
NW, RP	11.1	11	12
SN, ST	11.0	11	11
HE, TH	10.1	10	11
BB, MV	10.0	10	10
BE	9.1	9	10
HB, HH, NI, SH	9.2	9	10

Notes: Mean number of public holidays per year by federal state. Excludes Ostersonntag and Pfingstsonntag. States grouped by holiday count. Cross-state variation arises from regionally-specific holidays: Fronleichnam (Corpus Christi) is observed only in BW, BY, HE, NW, RP, SL, and parts of SN and TH; Allerheiligen (All Saints') only in BW, BY, NW, RP, SL; Heilige Drei Könige (Epiphany) only in BW, BY, ST; Mariä Himmelfahrt only in Catholic municipalities of BY.

Table A.3 summarizes cross-state variation in holiday counts. Southern states (Baden-Württemberg, Bavaria, Saarland) celebrate the most public holidays (12.1 per year on average), while northern city-states (Berlin, Bremen, Hamburg) and some coastal states (Schleswig-Holstein) observe the fewest (9.1–9.2 per year). This cross-sectional variation is absorbed by state fixed effects in the main analysis; identification comes from the within-state-year variation in whether a given holiday falls on a Sunday versus a weekday.

A.2 Additional Figures

Figure A.1: The Distribution of Moving Public Holidays over Weekdays in Germany



Notes: This figure shows the distribution of all moving public holidays in the sample (2005–2019) across weekdays. "Moving" holidays are those that fall on different weekdays in different years and are observed in at least one German federal state more than once. The near-uniform distribution confirms that the weekday on which a holiday falls is quasi-random over time, supporting the identification strategy that compares holidays falling on Sundays versus weekdays. Some holidays (e.g., Reformationstag) were introduced in additional states during 2018–2019, creating slight imbalance in later sample years; Appendix A.4 shows results are robust to excluding these years.

A.3 Robustness Check Using National Business Activity Index

The main estimates use monthly manufacturing data at the state level, exploiting quasi-random variation in holiday timing across states, months, and years. A natural question is whether holiday timing effects are visible in broader measures of economic activity. This appendix presents a robustness check using a national business activity index that covers a substantially wider range of economic sectors.

Data and Measurement. I draw on Destatis' experimental VAT-based early indicator ("Frühindikator aus Umsatzsteuervoranmeldungen"), which provides a real, calendar- and seasonally-adjusted monthly revenue index for business sectors B–N excluding E and K according to the NACE classification. This indicator covers approximately 60% of the German economy and includes not only manufacturing but also construction, trade, transport, hospitality, and business services. The index is normalized to 100 in June 2021.

Because this indicator is available only as a national aggregate, I lose the state-level variation that provides additional differences in sunday holidays. To construct appropriate holiday measures, I calculate GDP-weighted national aggregates of state-level holiday exposure for each year-month, using 2019 state GDP shares as weights. As in the main analysis, I exclude "Ostersonntag" (Easter Sunday) and "Pfingstsonntag" (Whit Sunday) from the holiday counts, as these are always on Sunday by definition and provide no quasi-random variation.

Empirical Specification. The national time-series structure limits the ability to include the full set of fixed effects used in the main analysis. I therefore estimate:

$$y_{t,m} = \beta \cdot \text{SundayHolidays}_{t,m}^{\text{national}} + \delta \cdot \text{TotalHolidays}_{t,m}^{\text{national}} + \lambda \cdot t + \mu_m + \varepsilon_{t,m}$$

where $y_{t,m}$ is the business activity index in year t and calendar month m (expressed as percentage deviation from the June 2021 baseline), $\lambda \cdot t$ is a linear year trend capturing secular growth, and μ_m are calendar-month fixed effects.

Table A.4: National Robustness Check: VAT-Based Business Activity Index

	(1) Baseline	(2) No total holidays	(3) Year FE
GDP-weighted Sunday holidays	0.008	0.008	0.005
	(0.007)	(0.007)	(0.007)
GDP-weighted total holidays	-0.002		-0.002
	(0.006)		(0.004)
Year	0.022***	0.022***	
	(0.000)	(0.000)	
Month FE	Yes	Yes	Yes
Year FE	No	No	Yes
Observations	131	131	131
R^2	0.902	0.901	0.940

Notes: Dependent variable is the Destatis VAT-based early indicator for business sectors B–N (excluding E, K), expressed as percentage deviation from June 2021 baseline. The indicator is real, calendar- and seasonally-adjusted by Destatis. GDP-weighted holiday measures aggregate state-level holiday counts using 2019 GDP shares. Ostersonntag and Pfingstsonntag excluded (always Sunday). Sample: January 2015 – December 2025 (N=131 months). Robust standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Results and Interpretation. Table A.1 presents the results. The coefficient on GDP-weighted Sunday holidays is positive (+0.008, SE = 0.007) but not statistically significant at conventional levels. This positive coefficient is directionally consistent with the main manufacturing estimates (Table 1, Column 2: +0.032 for log revenue per employee). The smaller magnitude—roughly 25% of the main estimate—is expected for several reasons: (1) national aggregation eliminates the within-state variation that provides additional identifying power in the main specification; (2) the VAT indicator includes many service sectors where holiday timing may have weaker effects compared to manufacturing; (3) Destatis applies calendar and seasonal adjustment procedures that may partially absorb working-day variation; and (4) with only 131 monthly observations, the specification has substantially less power than the main state-month panel (N = 2,880).

While the national business activity index does not provide independent confirmation at conventional significance levels, the positive point estimate is reassuring. The direction of the effect aligns with the manufacturing estimates, and the smaller magnitude is consistent with expected attenuation. I interpret this as providing qualified supportive evidence that does not contradict the main findings.

A.4 Robustness Check: Excluding 2018–2019

Several German states introduced new public holidays between 2018 and 2019. In 2018, Reformationstag (October 31) became a permanent holiday in Bremen, Hamburg, Lower Saxony, and Schleswig-Holstein—it was already observed in the five eastern states (Brandenburg, Mecklenburg-Vorpommern, Saxony, Saxony-Anhalt, and Thuringia). In 2019, Berlin introduced Weltfrauentag (International Women's Day, March 8), and Thuringia introduced Weltkindertag (World Children's Day, September 20). These late-sample institutional changes could potentially affect the estimates if the new holidays systematically differ in their timing or economic impact.

To assess robustness, I re-estimate the main specification excluding observations from 2018–2019. Table A.4 compares results from the full sample (2005–2019, N = 2,880) with the restricted sample (2005–2017, N = 2,496).

Table A.5: Robustness Check: Excluding 2018–2019

	(1) Revenue (Full)	(2) Revenue (Excl. 2018–19)	(3) Hours (Full)	(4) Hours (Excl. 2018–19)
Sunday Holidays	0.032**	0.033***	0.026***	0.027***
	(0.012)	(0.011)	(0.006)	(0.005)
Total Holidays	−0.028***	−0.029***	−0.035***	−0.036***
	(0.004)	(0.004)	(0.002)	(0.002)
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Calendar Month FE	Yes	Yes	Yes	Yes
Sample	2005–19	2005–17	2005–19	2005–17
N	2,880	2,496	2,880	2,496
R^2	0.929	0.937	0.751	0.750

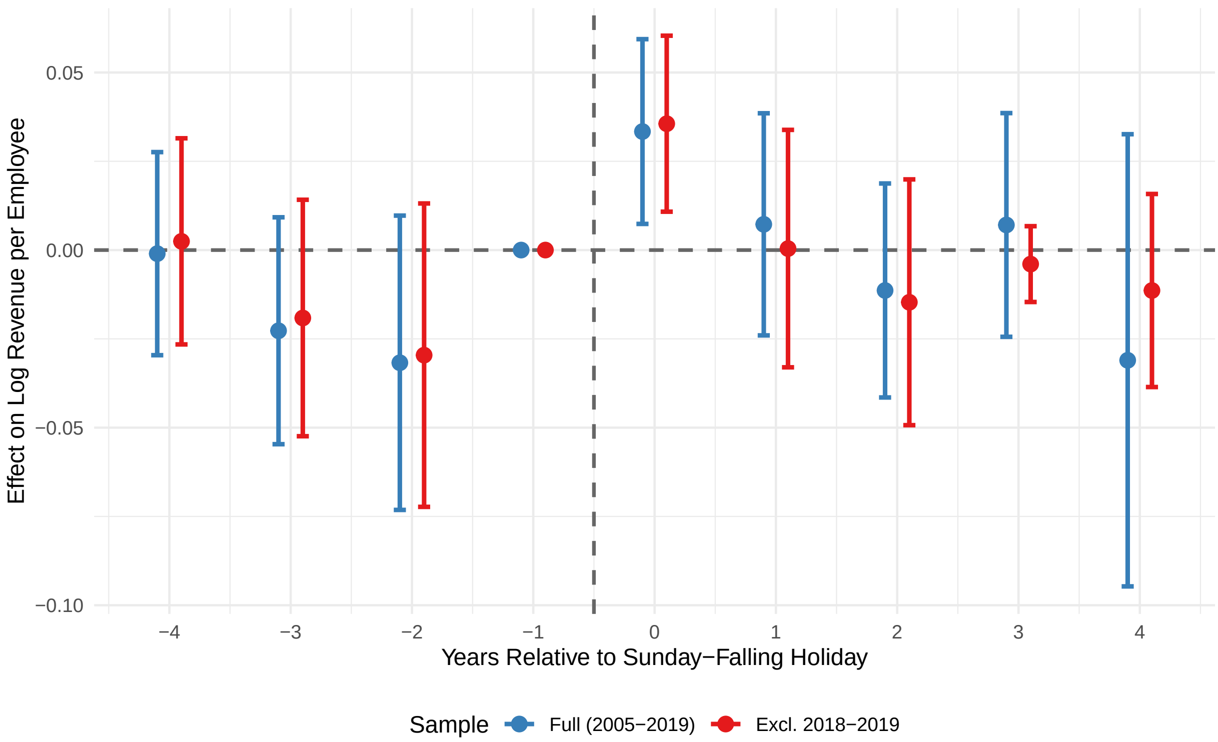
Notes: Columns (1) and (3) replicate the main specification from Table 1 (full sample 2005–2019). Columns (2) and (4) exclude 2018–2019 to assess sensitivity to new holidays introduced in those years (Reformationstag expansion, Weltfrauentag, Weltkindertag). Standard errors clustered by state-year-month in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

The coefficient on Sunday Holidays is virtually unchanged across samples. For revenue per employee, the estimate increases marginally from 0.032 (full sample) to 0.033 (restricted sample), a difference of less than 4%. For hours per employee, the estimate increases from 0.026

to 0.027. Both changes are well within one standard error and statistically indistinguishable from the baseline estimates.

Figure A.2: Event Study Robustness: Full Sample vs. Excluding 2018–2019

(a)



Notes: This figure compares event study estimates from the full sample (2005–2019, blue) with estimates excluding 2018–2019 (red). Both specifications show similar pre-treatment coefficients near zero, supporting parallel trends. The treatment effect at k = 0 is 0.033 in the full sample and 0.036 in the restricted sample. Error bars indicate 95% confidence intervals with standard errors clustered at the event cohort level.

Figure A.2 presents the event study comparison. The treatment effect at k = 0 is 0.033 in the full sample and 0.036 in the restricted sample—again, slightly larger when excluding the recent years. Pre-treatment coefficients remain close to zero in both specifications, supporting the parallel trends assumption.

These results confirm that the new holidays introduced in 2018–2019 do not drive the main findings. If anything, the effects are marginally larger when these years are excluded, suggesting that the baseline estimates are conservative.

A.5 Heterogeneity Analysis

This section explores whether the effects of Sunday-falling holidays differ across seasons and state groups, addressing concerns about potential heterogeneity in the treatment effect.

Seasonal Heterogeneity. The identifying variation from Sunday-falling holidays is concentrated in specific months: January (New Year's Day), May (Labor Day), October/November (German Unity Day, Reformation Day, All Saints), and December (Christmas). To assess whether effects differ by season, I estimate separate regressions for three seasonal groups: Winter (January and December), Spring (May), and Fall (October and November).

State Group Heterogeneity. Bavaria and Baden-Württemberg have notably more public holidays per year (approximately 12) compared to other states (9–11 holidays), reflecting their predominantly Catholic populations and additional regional observances. I compare these two southern states with the remaining 14 states to test whether the effect differs across regions with different holiday densities.

Table A.6: Heterogeneity Analysis: Effects of Sunday-Falling Holidays by Season and State Group

	(1) Baseline	(2) Winter	(3) Spring	(4) Fall	(5) BW/BY	(6) Other
Sunday Holidays	0.032**	0.065*	0.053***	-0.006	0.043	0.031**
	(0.012)	(0.031)	(0.012)	(0.008)	(0.019)	(0.012)
Months	All	Jan, Dec	May	Oct, Nov	All	All
States	All 16	All 16	All 16	All 16	BW, BY	14 others
N	2,880	480	240	480	360	2,520

Notes: Dependent variable is log real revenue per employee. All specifications include state and year fixed effects. Columns (1), (5), (6) also include month FE. Columns (2)–(4) restrict to months with Sunday-holiday variation. Total Holidays control included but not shown. Standard errors clustered by state-year-month (Cols 1, 5, 6) or state-year (Cols 2–4). * p<0.10, ** p<0.05, *** p<0.01.

Table A.5 presents the results. **Seasonal heterogeneity** shows some variation in point estimates across seasons. Winter holidays (Christmas, New Year's Day) show the largest effect (0.065), while Spring holidays (Labor Day) show a similar magnitude to the baseline (0.053). Fall holidays (German Unity Day, Reformation Day, All Saints) show a near-zero and insignificant effect (-0.006). The Winter and Spring estimates are both positive and significant, consistent with the main findings. The Fall estimate is based on fewer Sunday-holiday occurrences (31 vs. 121 for Winter) and may reflect limited statistical power or genuine differences in how firms respond to autumn holidays.

State group heterogeneity shows minimal differences. The coefficient for Bavaria and Baden-Württemberg (0.043) is slightly larger than for other states (0.031), but the difference is not statistically significant. This similarity is expected: state fixed effects already absorb level differences in holiday counts, so this test examines whether the *effect* of Sunday-falling holidays differs, which is a weaker hypothesis. The similar coefficients suggest the mechanism operates consistently across regions with different holiday densities and industrial compositions.

Overall, the heterogeneity analysis does not reveal systematic patterns that would undermine the main findings. Effects are positive and significant for Winter and Spring holidays, and similar across state groups. The null effect for Fall holidays deserves further investigation but does not negate the robust findings for other seasons.

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