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Final Report

Bachelor's Degree in Economics

THE EFFECT OF AIR POLLUTION AND TEMPERATURE ON CRIMINAL ACTIVITY: A LITERATURE REVIEW

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ABSTRACT

This thesis reviews the empirical economic literature on the effects of two environmental factors — ambient temperature and air pollution — on criminal activity. Drawing on more than fifty studies across economics, criminology, and environmental science, it sets out the main theoretical channels through which environmental conditions may influence crime — physiological aggression, routine-activity, and neuro-inflammatory mechanisms — and then critically assesses the empirical evidence for each. The temperature–crime literature, built largely on panel fixed-effects designs, documents a consistent and economically meaningful association between heat and violent crime, with effects concentrated in impulsive, interpersonal offences and a pronounced nonlinearity at high temperatures. The smaller air pollution–crime literature, relying on quasi-experimental and instrumental-variable strategies, points to a comparable effect of fine particulate matter and ozone on impulsive crime. Throughout, the review weighs the credibility of competing identification strategies, engages with recent challenges to the robustness of these findings, and distinguishes well-identified studies from purely correlational ones. It then identifies the principal gaps that remain — most notably the joint estimation of the two channels, the under-use of calls-for-service data, and the limited geographic scope of the pollution literature — and links them to a large panel dataset, assembled during an associated internship, that is designed to address them in future empirical work.

Keywords: temperature; air pollution; crime; environmental economics; literature review; panel data; instrumental variables.

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INTRODUCTION

This thesis reviews the empirical literature on the relationship between two environmental factors — ambient temperature and air pollution — and criminal activity. Over the past two decades, these two strands of research have emerged as distinct but related fields within environmental economics and criminology. The temperature–crime literature, now comprising over 40 studies, has documented a consistent positive association between heat and violent crime across multiple countries and time periods. The air pollution–crime literature, smaller and more recent, has produced quasi-experimental evidence consistent with a causal effect of fine particulate matter ($PM_{2.5}$) and ground-level ozone on impulsive violent behaviour, operating through hypothesised neuroinflammatory pathways.

This review addresses three research questions:

1. **What does the existing evidence tell us about the causal relationship between temperature and crime?** Specifically, what is the estimated magnitude, which crime types are most affected, is the relationship linear or nonlinear, and how consistent are the findings across geographic and institutional contexts?

2. **What does the existing evidence tell us about the causal relationship between air pollution and crime?** What identification strategies have been used to overcome the endogeneity of pollution exposure, and what do the quasi-experimental estimates reveal about the magnitude and mechanism of the effect?

3. **What are the main gaps and limitations in the current literature, and what directions should future research take?** In particular, can the two channels be studied jointly, and what data improvements are needed?

There are three reasons why this topic deserves attention. **First, climate change is making the problem worse.** Global temperatures are rising, and heat waves are becoming more frequent and more intense. If higher temperatures cause more crime — as the evidence reviewed in this thesis strongly suggests — then climate change carries an additional social cost that has only recently been quantified. Ranson (2014) estimated that warming could produce an additional 22,000 murders and 3.5 million property crimes in the United States alone by 2099. Understanding the temperature–crime relationship is essential for accurate climate impact assessment.

Second, air pollution remains a major global challenge. Despite significant improvements in air quality in high-income countries, billions of people worldwide are still exposed to pollution levels well above WHO guidelines. If pollution impairs cognitive function and increases aggression — as the neuropsychological evidence suggests — then the benefits of air quality regulation extend beyond health to include reduced criminal victimisation. This dimension is currently absent from cost-benefit analyses of environmental policy.

Third, environmental inequality compounds social inequality. Low-income and minority communities are disproportionately exposed to both extreme heat and air pollution. If these environmental exposures cause crime, then environmental inequality translates directly into crime inequality through biological mechanisms, compounding the socioeconomic disadvantages already faced by these communities. Heilmann et al. (2021) provide direct evidence for this channel, showing that temperature effects on crime are concentrated in high-poverty neighbourhoods.

This review covers over 50 studies published between 1987 and 2026, drawn from economics, criminology, epidemiology, and environmental science journals. The literature was identified through three channels: (i) a curated reading list provided by the supervisors, comprising key references in both the temperature–crime and pollution–crime fields; (ii) backward citation tracking from recent high-impact studies (Herrnstadt et al., 2021; Heilmann et al., 2021; Cohen and Gonzalez, 2024); and (iii) targeted searches in Google Scholar and EconLit for recent working papers and forthcoming articles.

The review is organised thematically rather than chronologically. The temperature–crime and pollution–crime literatures are treated separately because they involve distinct identification challenges, different environmental variables, and largely non-overlapping sets of authors and journals. Within each strand, studies are grouped by methodological approach — from early cross-sectional and time-series analyses to modern panel fixed-effects and instrumental-variable strategies — to highlight how the literature has evolved toward progressively stronger identification strategies.

For each study reviewed, attention is given to four dimensions: (i) the data used (geographic scope, temporal resolution, crime outcome measure); (ii) the identification strategy (what sources of variation are exploited, what fixed effects are included, what instruments are used); (iii) the main findings (magnitude, statistical significance, heterogeneity); and (iv) the limitations and potential threats to validity.

The thesis is organised into four chapters, preceded by this Introduction and followed by the Conclusions.

Chapter I — Theoretical Background and Mechanisms lays the conceptual foundation, presenting the theoretical frameworks that explain why environmental conditions might affect crime and discussing the long-run neurotoxic effects of lead.

Chapter II — Temperature and Crime reviews the first empirical strand, moving from early cross-sectional evidence to the modern panel fixed-effects literature, international evidence, and specific crime subtypes, before turning to the existing reviews and meta-analyses.

Chapter III — Air Pollution and Crime reviews the second strand, setting out the identification challenge posed by the endogeneity of pollution and the main quasi-experimental strategies used to address it, together with the emerging use of Boundary Layer Height as an instrument.

Chapter IV — Discussion and Synthesis brings the two strands together, compares them across key dimensions, identifies the main gaps, and draws out the policy implications and recommendations for future research.

The **Conclusions** summarise the three main findings of the review and their policy implications.

CHAPTER I

THEORETICAL BACKGROUND AND MECHANISMS

This chapter outlines the theoretical channels through which temperature and air pollution may affect criminal behaviour. Three main frameworks have been proposed: the affect/aggression model, the routine activities theory, and the neuropsychological channel. The first two apply primarily to temperature; the third is the dominant mechanism for pollution, though all three interact in practice.

I.1 THE GENERAL AGGRESSION MODEL

The most widely cited framework linking heat to crime is the General Aggression Model (GAM), synthesised by Anderson (2001). The GAM posits that uncomfortably hot temperatures increase aggressive behaviour through a chain of physiological and cognitive processes.

First, heat stress elevates heart rate, skin conductance, and cortisol levels, producing heightened physiological arousal. Second, in this state, individuals are more likely to interpret ambiguous social cues as hostile or threatening — a phenomenon known as hostile attribution bias. Third, heat depletes the cognitive resources required for self-regulation and impulse control, lowering the threshold for aggressive responses. Fourth, the combination of heightened arousal, hostile appraisal, and diminished self-control increases the probability of aggressive action in response to interpersonal provocation.

The GAM predicts that temperature effects should be strongest for impulsive, interpersonal crimes — particularly assault, domestic violence, and disputes — rather than for premeditated offenses like burglary or fraud. This prediction is broadly supported by the empirical evidence reviewed in Chapter II.

An important debate concerns the functional form of the relationship. Anderson (2001) argued for a monotonically increasing relationship: hotter temperatures always produce more aggression. However, the "negative affect escape" model proposed by Baron and Bell (1976) predicts an inverted-U relationship: moderate heat increases aggression, but extreme heat motivates escape and withdrawal, reducing conflict. The empirical evidence on this question is reviewed in Section II.3.

I.2 ROUTINE ACTIVITIES THEORY

The routine activities theory (Cohen and Felson, 1979) offers a complementary explanation that does not require any psychological mechanism. The theory posits that crime occurs when three elements converge in space and time: a motivated offender, a suitable target, and the absence of a capable guardian. Weather affects the spatial and temporal distribution of these elements by altering daily routines.

Warm weather draws more people outdoors and into public spaces — parks, streets, bars, entertainment districts — increasing the density of potential offenders and targets in unsupervised settings. This mechanism predicts positive temperature effects on both violent and property crime, since more people outdoors means more opportunities for both interpersonal conflict and theft. Effects should be concentrated during leisure hours (evenings, weekends) when weather most influences outdoor activity, and should be reduced at extreme heat as people retreat into air-conditioned environments.

Jacob et al. (2007) designed an empirical test to distinguish the two channels by examining property crime (which only the routine-activities theory predicts should increase) versus violent crime (which both theories predict should increase). Their finding that temperature strongly predicts violent crime but not property crime is interpreted as evidence favouring the aggression mechanism.

I.3 THE NEUROPSYCHOLOGICAL CHANNEL

The primary mechanism linking air pollution to crime operates through neuroinflammation and impaired executive function. This channel has been articulated by Burkhardt et al. (2019) and Lu et al. (2018).

Fine particulate matter ($PM_{2.5}$) — particles with aerodynamic diameter ≤ 2.5 micrometres — penetrates deep into the lungs and enters the bloodstream, triggering systemic inflammatory responses. Ozone causes oxidative stress with similar downstream effects.

Inflammatory cytokines and ultrafine particles cross the blood-brain barrier, causing inflammation in brain tissue, particularly in the prefrontal cortex — the region responsible for executive function, impulse control, and rational decision-making. Although this review labels the contemporaneous pollution mechanism 'neuroinflammation', part of the environmental-health literature classifies the acute passage of ultrafine particles across the blood-brain barrier as a form of short-term neurotoxicity — a framing that situates this channel on a continuum with the long-run neurotoxic effects discussed in Section I.4. Reduced prefrontal cortex function diminishes individuals' ability to suppress impulsive urges, increasing the probability of aggressive or antisocial behaviour. Air pollution also causes direct physical discomfort — respiratory irritation, headaches — that elevates baseline irritability and reduces tolerance for interpersonal friction.

Lu et al. (2018) provide direct experimental evidence for this pathway. In laboratory studies, participants exposed to polluted conditions reported higher anxiety and engaged in more unethical behaviour, with effects mediated by self-reported anxiety.

A countervailing mechanism operates through avoidance behaviour. Visible air pollution may deter outdoor activity, reducing the pool of potential offenders and victims. This routine-activities effect works in the opposite direction to the neuropsychological channel, and the net observed effect depends on which dominates.

I.4 LONG-RUN NEUROTOXIC EFFECTS

A distinct mechanism, applicable primarily to lead exposure, operates over decades. Reyes (2007) argued that childhood exposure to environmental lead — primarily from leaded gasoline — causes permanent neurodevelopmental damage affecting impulse control, attention, and emotional regulation. As exposed cohorts reach the crime-prone age range (15–25), this translates into elevated crime rates.

This mechanism is fundamentally different from the contemporaneous effects studied in the rest of the pollution–crime literature, but it established the principle that environmental pollutants can causally affect criminal behaviour through neurological pathways.

I.5 SUMMARY OF THEORETICAL PREDICTIONS

Tab. I.1 summarises the theoretical predictions linking environmental factors to crime through different mechanisms.

Tab. I.1 — Summary of theoretical mechanisms

Mechanism	Environmental Factor	Crime Types Affected	Temporal Lag
Aggression/affect (GAM)	Temperature	Violent (assault, DV, disputes)	Hours
Routine activities	Temperature	Violent + property	Hours
Cognitive depletion	Temperature	Impulsive (assault, DUI, disorder)	Hours
Neuroinflammation	Air pollution ($PM_{2.5}$, O_3)	Violent, disorder	Hours–days
Irritability/discomfort	Air pollution	Disputes, DV, disorder	Hours
Avoidance (countervailing)	Visible pollution	Reduces outdoor crime	Hours
Neurotoxicity (lead)	Lead exposure	All crime types	Years–decades

CHAPTER II

TEMPERATURE AND CRIME

This chapter reviews the empirical literature on the relationship between ambient temperature and criminal activity. The review is organised by methodological approach: from early cross-sectional studies, through modern panel fixed-effects analyses, to recent work on nonlinear effects, international evidence, and specific crime subtypes.

II.1 EARLY AND CROSS-SECTIONAL EVIDENCE

The earliest systematic studies relied on aggregate time-series data or cross-sectional comparisons. While limited by the inability to control for unobserved confounders, they established basic empirical regularities that subsequent work has sought to explain causally.

Craig (1987) proposed one of the first formal models linking temperature to criminal motivation through physiological arousal. Field (1992) analysed quarterly crime data in England and Wales over several decades and documented strong seasonal patterns: property crimes peaked in winter — attributed to longer hours of darkness — while violent crimes peaked in summer. This divergence became a recurring finding, consistent with the aggression mechanism for violence and the opportunity mechanism for property crime.

Anderson (2001) provided an early and widely cited review, synthesising laboratory experiments, field studies, and aggregate data. He concluded that the evidence "strongly and consistently" supports the heat hypothesis and estimated that a 2°F increase in average temperature would produce approximately 24,000 additional assaults and murders per year in the United States.

II.2 PANEL FIXED-EFFECTS STUDIES

The methodological standard shifted in the mid-2000s toward panel data with fixed effects, which control for time-invariant unobserved characteristics and common temporal shocks.

II.2.1 Jacob, Lefgren, and Moretti (2007)

Jacob et al. (2007) is among the earliest panel studies in this literature. Using daily crime data at the police-beat level, they estimated the effect of temperature after absorbing beat fixed effects and temporal controls. Their key findings were that a 10°F increase in temperature increases assaults by approximately 5%, while property crime shows no significant response once fixed effects are included. The zero property-crime effect is interpreted as evidence against the routine-activities explanation and in favour of the aggression mechanism.

II.2.2 Ranson (2014)

Ranson (2014) offers the broadest coverage among the panel studies, using county-month data covering the entire contiguous United States over 1960–2009. Murder increases by approximately 2.3% per °C, and assault is the most temperature-responsive category at 3–5% per degree. Property crimes show small positive effects. Using climate projections, Ranson estimated that warming could produce an additional 22,000 murders and 3.5 million property crimes by 2099. This study established that temperature–crime effects are consistent across the United States.

II.2.3 Heilmann, Kahn, and Tang (2021)

Heilmann et al. (2021) used daily crime data from Los Angeles at fine spatial resolution to examine differential effects across neighbourhood income levels. Days above 85°F increase violent crime by 5.7% compared to the 65–70°F range. Crucially, effects are concentrated in high-poverty areas, where residents have less access to air conditioning and spend more time outdoors. This finding highlights the distributional consequences of climate change.

II.2.4 Cohen and Gonzalez (2024)

Cohen and Gonzalez (2024), published in the American Economic Journal: Economic Policy, analyse the temperature–crime relationship in Mexico, combining millions of administrative crime records with victimisation surveys and daily weather data. Their distinctive contribution is to the mechanism: they estimate that shifts in alcohol consumption and time use on weekends account for roughly 28% of temperature-induced crimes, and they document accompanying changes in the timing and location of offences. The study thus provides some of the most direct evidence for the routine-activities and time-use channel set out in Section I.2.

II.2.5 Other panel studies

Blakeslee and Fishman (2018) study rural India at the district-year level and find strongly nonlinear effects: crime rises sharply above a comfort threshold. Baryshnikova et al. (2022) exploit daily variation across Australian states and find significant heat effects on assault. Churchill et al. (2023) use Australian data and find that temperature increases property crime in some specifications. Horrocks and Menclova (2011) study New Zealand and find positive temperature effects on violent crime.

Tab. II.1 summarises the main panel fixed-effects studies.

Tab. II.1 — Key panel fixed-effects studies on temperature and crime

Study	Setting	Data	Main Finding
Jacob et al. (2007)	U.S. city	Daily, beat-level	+5% assault per 10°F; no property effect
Ranson (2014)	U.S. national	County-month, 1960–2009	+2.3% murder per °C
Heilmann et al. (2021)	Los Angeles	Daily, tract-level	+5.7% violent crime above 85°F
Cohen & Gonzalez (2024)	Mexico	Municipality-day	↑ crime; ~28% via time use and alcohol
Blakeslee & Fishman (2018)	India	District-year	Nonlinear; sharp rise above threshold
Baryshnikova et al. (2022)	Australia	Daily, state-level	Significant heat effects on assault
Almås et al. (2025)	Norway	Daily	Effects even in cold-climate countries

II.3 NONLINEAR EFFECTS AND EXTREME HEAT

A key empirical question is whether the temperature–crime relationship is linear or nonlinear.

Evidence on the functional form comes mainly from studies that estimate flexible temperature–response functions. Ranson (2014), in particular, finds that crime rises with temperature across most of the observed range, with the largest effects at high temperatures and little sign of the sharp reversal at extreme heat that the negative-affect-escape model would predict. Within the temperature ranges these panel studies observe, this broadly monotonic pattern is more consistent with Anderson's (2001) model than with Baron and Bell's (1976) inverted-U hypothesis.

Blakeslee and Fishman (2018) find similar nonlinearities in India, with the marginal effect increasing at higher temperatures. These findings suggest that extreme heat events — not average warming — drive most of the temperature–crime relationship.

II.4 INTERNATIONAL AND CROSS-COUNTRY EVIDENCE

While U.S. evidence is the most extensive, a number of studies examine other settings.

Beyond the United States, several studies test whether the temperature–crime relationship generalises across institutional and climatic settings, and the studies differ considerably in how credibly they identify it. The most informative exploit panel variation: Otrachshenko and Popova (2020), covering 39 European countries, find that extreme heat raises crime most sharply in southern Europe, while Almås et al. (2025) report temperature effects even in Norway. The Norwegian case is of particular analytical interest, because a cold-climate setting offers a sharp test of mechanism. If heat raised crime purely by drawing people outdoors, its effect should be muted where warm days are rare; the persistence of an effect there is therefore more consistent with a physiological channel that operates across the temperature distribution than with a pure opportunity story. Other settings broaden the geographic base but vary in data quality and identification: Baysan et al. (2019) link temperature to organised-crime violence and suicides in Mexico, while Shen et al. (2020) in China, Potgieter et al. (2022) in South Africa, and Trujillo and Howley (2019) in a

Caribbean city report associations that are, in several cases, more exposed to omitted-variable bias than the fixed-effects designs reviewed above. Systematic reviews spanning multiple countries (Hou et al., 2023) reach broadly concordant conclusions.

Across these settings the evidence is uneven rather than uniformly confirmatory: a positive heat–violence association recurs, but is identified with varying credibility. The most rigorously identified studies, particularly the cold-climate cases, offer the firmest support for a partly physiological mechanism rather than a purely opportunity-driven one, while cross-country comparability remains limited by differences in crime recording, climate, and research design.

II.5 SPECIFIC CRIME SUBTYPES

II.5.1 Intimate partner violence

A recent sub-literature examines heat effects on intimate partner violence (IPV). Rizzotto et al. (2025) find that extreme heat days significantly increase IPV reports in Brazil, with effects concentrated among low-income households. Santonja et al. (2025) examine domestic violence in Spain and find strong temperature effects during heat waves. Sáenz-Molina (2025) confirms the relationship in Latin America. These studies suggest that heat-driven aggression extends to the domestic sphere.

A particularly notable contribution is Aina, Parisi, and Picchio (2026), which provides causal evidence on the relationship between temperature and gender-based violence (GBV) in Italy — one of the first studies from a high-income European setting. Using ten years of weekly province-level data (2013–2022) on helpline calls and femicides matched with high-resolution weather data, they employ a two-way fixed-effects strategy that exploits within-province temperature variation. They find that higher temperatures significantly increase both help-seeking behaviour (calls to the national 1522 helpline) and lethal violence (femicides). A novel finding is that elevated nighttime temperatures — proxied by weekly average minimum temperatures — are more consequential than daytime heat, suggesting that heat-induced sleep disruption may be an important but underexplored mechanism. Their heterogeneity analyses show that femicides exhibit a significantly stronger temperature response in provinces with higher air-conditioning penetration, while helpline calls respond more strongly in provinces with lower tertiary education attainment. The study is also careful to control for air pollution ($PM_{2.5}$ and ozone), a notable design feature given the joint-estimation gap identified in Chapter IV.

II.5.2 Property crime and other categories

The evidence on property crime is mixed. Ranson (2014) finds small positive effects, while Jacob et al. (2007) find no effect. The overall evidence suggests that temperature effects on property crime are smaller and less robust than effects on violent crime, consistent with the aggression rather than the routine-activities mechanism.

Cruz et al. (2020) and Le et al. (2022) examine additional crime categories and temporal patterns. McDowall et al. (2012) use formal time-series decomposition to document the seasonal component of crime across U.S. cities. Brunsdon et al. (2009) show that temperature effects are concentrated during evening and nighttime hours.

II.6 REVIEWS AND META-ANALYSES

Several review articles have synthesised this literature. Burke et al. (2015) estimate a median effect of 4% increase in interpersonal violence per 1 standard deviation of temperature across 55 studies. Corcoran and Zahnow (2022) review over 50 studies and call for finer temporal resolution. Choi et al. (2024) review the evidence from an environmental health perspective. Azan et al. (2025) provide an updated review through a public health lens.

Lynch et al. (2020) discuss methodological challenges in weather–crime research. Ankel-Peters et al. (2022), in a critical paper published in Q Open, raise concerns about the robustness of some temperature–crime estimates, particularly when alternative specifications or corrections for multiple testing are applied.

CHAPTER III

AIR POLLUTION AND CRIME

This chapter reviews the empirical literature on the relationship between air pollution and criminal activity. Compared to the temperature–crime literature, this strand is newer (most studies post-2018), smaller (approximately 17 studies), and more reliant on quasi-experimental identification.

III.1 FOUNDATIONAL EVIDENCE: LEAD AND CRIME

Reyes (2007) examined childhood lead exposure from leaded gasoline and subsequent criminal behaviour. Exploiting state-level variation in the timing of the phase-out, she estimated that reduced lead exposure accounted for approximately 56% of the decline in violent crime during the 1990s. While the mechanism — childhood neurotoxicity affecting adult behaviour — operates over decades, the study established that environmental pollutants can causally affect criminal behaviour through neurological pathways.

III.2 THE IDENTIFICATION CHALLENGE

The core challenge in estimating the causal effect of air pollution on crime is endogeneity. Pollution correlates with poverty and residential segregation, economic activity and traffic, and weather conditions that independently affect crime. To address these challenges, the recent literature has employed several identification strategies: wind direction (Herrnstadt et al., 2021), atmospheric inversions (Bondy et al., 2020), wildfire smoke (Jones, 2022), and Boundary Layer Height (Kircheis, 2026; Zárate-Barrera, 2022). Each exploits a source of plausibly exogenous variation in pollution that is orthogonal to local crime determinants. For example, Boundary Layer Height — the depth of the atmospheric layer within which pollutants disperse — is governed by large-scale meteorological processes and generates variation in surface pollution concentrations that is largely independent of human activity. It is therefore expected to be correlated with pollution while remaining orthogonal to the behavioural and socioeconomic determinants of crime, conditional on appropriate meteorological controls such as temperature, wind speed, and precipitation.

III.3 QUASI-EXPERIMENTAL STUDIES

III.3.1 Herrnstadt, Heyes, Muehlegger, and Saberian (2021)

Herrnstadt et al. (2021), published in the American Economic Journal: Applied Economics, exploit wind direction in Chicago as an instrument for $PM_{2.5}$. When winds blow from major pollution sources (highways, industrial zones), downwind blocks experience exogenous pollution spikes. A one-standard-deviation increase in $PM_{2.5}$ increases violent crime by 1.4%. Effects are concentrated in assaults and absent for property crime. Instrumental-variable estimates are larger than OLS estimates, suggesting attenuation from measurement error.

III.3.2 Bondy, Roth, and Sager (2020)

Bondy et al. (2020), published in JAERE, study London using thermal inversions as an instrument. A 10 $\mu g/m^3$ increase in instrumented $PM_{2.5}$ increases total crime by approximately 0.9%, driven by violent crime and antisocial behaviour. Effects are immediate (same-day) with no significant lagged effects, suggesting an acute neurological mechanism.

III.3.3 Jones (2022)

Jones (2022), published in JEEM, exploits wildfire smoke plumes in the western United States. Smoke from remote wildfires produces $PM_{2.5}$ spikes in distant urban areas unrelated to local conditions. Smoke-driven $PM_{2.5}$ significantly increases assaults.

III.3.4 Burkhardt et al. (2019)

Burkhardt et al. (2019), also in JEEM, exploit the EPA's Air Quality Index notification system. They find that both $PM_{2.5}$ and ozone affect crime, using the regulatory threshold as a discontinuity. A companion paper by Burkhardt et al. in the Journal of Environmental Economics and Policy extends this analysis.

Tab. III.1 summarises the quasi-experimental studies.

Tab. III.1 — Key quasi-experimental studies on air pollution and crime

Study	Setting	Instrument	Main Finding
Herrnstadt et al. (2021)	Chicago	Wind direction	+1.4% violent crime per SD of $PM_{2.5}$
Bondy et al. (2020)	London	Thermal inversions	+0.9% total crime per 10 μg/m³ $PM_{2.5}$
Jones (2022)	Western U.S.	Wildfire smoke	Significant increase in assaults
Burkhardt et al. (2019)	U.S.	AQI thresholds	$PM_{2.5}$ and O_3 affect crime

III.4 CORRELATIONAL AND MULTI-CITY STUDIES

Several studies provide broader geographic coverage using panel fixed effects without instrumental-variable strategies.

A second group of pollution–crime studies trades the sharp identification of the quasi-experimental designs for broader geographic coverage, relying on panel fixed effects or cross-sectional associations. These vary markedly in credibility. The better-identified of them exploit policy-induced variation in pollution: Chen and Li (2020), for example, use the NO_x Budget Program as a source of plausibly exogenous variation across Chinese cities. Others remain essentially correlational — Kuo and Putra (2021) across 14 U.S. cities, Wesselbaum (2022) in a cross-country sample, Demir and Ozcan (2023) in Turkey, and Singh and Visaria (2021) in India — and, while broadly consistent in sign with the quasi-experimental literature, cannot exclude that pollution proxies for unobserved economic or social conditions that independently drive crime. Berman et al. (2019) and Batkeyev and DeRemer (2023) add further associational and behavioural evidence, and Kishore et al. (2026) extend the question to intimate partner violence. The contribution of this strand is therefore corroborative rather than confirmatory: its breadth shows that the association is not an artefact of any single city or instrument, but the weaker designs warrant correspondingly less weight, and it is their convergence with the more rigorously identified studies that supports the overall conclusion.

Kishore et al. (2026) study the effect of air pollution on intimate partner violence and find significant effects, consistent with the neuroinflammatory mechanism.

A recurring limitation across this strand is that the functional form of the pollution–crime relationship remains poorly characterised. Most quasi-experimental studies estimate an average, approximately linear effect and do not trace the full dose–response curve. Several features of the literature explain this. The instruments used for identification — wind direction, atmospheric inversions, and boundary-layer height — generate variation around prevailing pollution levels, so the resulting estimates are local to the observed range and are ill-suited to recovering effects at extreme concentrations. Air-quality monitoring is also sparse and unevenly distributed, leaving the upper tail of the pollution distribution thinly sampled. And the short, high-frequency exposure windows that make identification credible limit the statistical power available to detect curvature. Where studies have looked, the picture is not uniform: evidence from Mexico City and India suggests that the marginal effect may even turn negative at very high pollution levels, as avoidance behaviour keeps potential offenders and victims indoors (Zárate-Barrera, 2022; Singh and Visaria, 2021). Establishing whether the relationship is monotonic, concave, or non-monotonic therefore remains an open question, and one that richer, more finely resolved data are needed to settle.

III.5 EXPERIMENTAL AND PSYCHOLOGICAL EVIDENCE

Lu et al. (2018), published in Psychological Science, provide micro-level evidence for the neuropsychological mechanism. Combining city-level field data with laboratory experiments, they demonstrate that pollution exposure increases anxiety and unethical behaviour, with anxiety as the psychological mediator. This study is important because it provides both macro and micro evidence and identifies the mechanism at the individual level.

III.6 THE BOUNDARY LAYER HEIGHT INSTRUMENT

Boundary Layer Height (BLH) — the depth of the atmospheric mixing layer — has emerged as a promising instrument for pollution. The relationship is straightforward: when BLH is low (200–500 m), pollutants are trapped near the surface; when BLH is high (1,500–3,000 m), pollutants disperse vertically. BLH is determined by large-scale meteorological processes and is orthogonal to local socioeconomic conditions.

Kircheis (2026) demonstrates the strong BLH–$PM_{2.5}$ relationship across geographic settings. Zárate-Barrera (2022) develops the BLH-based IV strategy for crime research. The instrument satisfies relevance (strong first-stage F-statistics) and exclusion (no plausible direct effect on crime after conditioning on temperature and weather). The main threat is that BLH correlates with temperature through solar heating; this is addressed by including flexible temperature controls in both stages.

CHAPTER IV

DISCUSSION AND SYNTHESIS

IV.1 COMPARING TEMPERATURE AND POLLUTION EFFECTS

The two literatures converge on several points. Both find that impulsive, interpersonal crimes — particularly assault and disorder — are the most responsive to environmental conditions, while premeditated property crimes show little or no response. This convergence across two distinct channels, studied by different groups using different methods, is consistent with a shared neuropsychological mechanism in which both heat and pollution are hypothesised to impair prefrontal-cortex function and reduce impulse control. This mechanism, however, is largely inferred from the pattern of behavioural results — in particular the concentration of effects in impulsive rather than premeditated crimes — rather than measured directly in the economic studies reviewed here.

Tab. IV.1 summarises the comparison.

Tab. IV.1 — Comparison of the two literatures

Dimension	Temperature–Crime	Pollution–Crime
Literature size	Large (~40 studies)	Small (~17 studies)
Geographic coverage	Global	Concentrated (U.S., U.K., China)
Dominant mechanism	Aggression + routine activities	Neuroinflammation
Most responsive crime	Assault, DV, disorder	Assault, disorder
Property crime effects	Small or zero	Zero
Estimated magnitude	1–5% per °C	1–3% per SD of $PM_{2.5}$
Identification	Panel FE	IV required
Nonlinearity	Well-documented	Poorly characterised

However, important differences exist. Temperature is more easily measured and assigned to geographic units, whereas pollution exposure depends on monitor proximity and introduces measurement error. The temperature literature benefits from a much larger evidence base and geographic coverage, while the pollution literature is more concentrated and leans more heavily on instrumental-variable strategies, by necessity.

IV.2 THE CHALLENGE OF JOINT ESTIMATION

A critical gap is that most studies examine one channel in isolation. Temperature and pollution are positively correlated: hot, stagnant days produce both heat stress and high pollutant concentrations. Studies estimating temperature effects without controlling for pollution — or vice versa — risk attributing to one channel what is partly caused by the other.

Only a few studies (e.g., Burkhardt et al., 2019; Kuo and Putra, 2021) include both covariates. Joint estimation requires data combining weather and pollution at compatible resolutions. Future research should explicitly address this by including both channels in the same regression framework.

IV.3 DATA AND MEASUREMENT ISSUES

IV.3.1 Crime data: reported crime vs. calls-for-service

Nearly all studies use reported crime data — records processed through the full criminal justice chain. An alternative source — Calls-for-Service (CFS) records — captures a broader range of events including disorder, disputes, and welfare checks. CFS data have advantages: they capture reactive demand for police services and include disorder categories absent from crime reports. The main limitation is that they reflect reporting behaviour, not necessarily crime incidence.

IV.3.2 Environmental data resolution

The spatial resolution of environmental data constrains estimated effects. Weather reanalysis products like ERA5 have grid spacings of approximately 25–28 km, coarser than typical police districts. Pollution monitoring networks are even more problematic: some cities have only one or two stations. Higher-resolution data and satellite-derived estimates could improve precision.

IV.3.3 Methodological concerns

A credible review must also weigh the evidence that qualifies, or runs against, the headline findings. Ankel-Peters et al. (2022) show that some widely cited temperature–crime estimates are sensitive to specification choices and do not always survive corrections for multiple hypothesis testing — a serious concern in a literature with many researcher degrees of freedom (the choice of temperature bins, lag structure, fixed effects, and crime aggregation) and strong incentives to report statistically significant results. Publication bias compounds the problem: null findings on a high-profile topic are less likely to be written up or accepted, so the published distribution of estimates may overstate the true average effect. Harp and Karnauskas (2020) add that the limited predictability of extreme-heat events bears on how usefully these relationships can be operationalised for policy.

These caveats do not overturn the central conclusion, but they do temper it. The strongest defence of the literature is not any single study but the convergence of independent designs — panel fixed effects, instrumental variables, laboratory experiments, and the parallel pollution results — on the same qualitative pattern, since these approaches do not share the same sources of bias. The most recent contributions continue to refine rather than reverse this picture (Berman et al., 2020; Xu et al., 2020; Lee and Lee, 2026; Lopes de Moraes et al., 2026). On balance, the direction of the effect is well established, while its precise magnitude remains uncertain and specification-dependent.

IV.3.4 Short-term identification and long-run climate effects

As Dell, Jones, and Olken (2014) emphasise in their review of the climate-economy literature, the modern panel approach exploits high-frequency weather fluctuations — day-to-day or month-to-month deviations from local norms — as exogenous shocks, conditional on location and time fixed effects. This strategy is compelling for identifying short-run causal effects, but climate change operates over decades. Two opposing considerations arise. On the one hand, long-run adaptation may attenuate the estimated effects: populations may invest in air conditioning, adjust daily routines, or develop institutional responses (such as heat-alert policing protocols) that reduce the sensitivity of crime to temperature over time (Carleton and Hsiang, 2016). On the other hand, cumulation may amplify them: sustained exposure to higher baseline temperatures could produce chronic stress, sleep deprivation, or social frictions whose effects compound beyond what is captured by short-run variation. Hsiang (2016) formalises this distinction, showing that the mapping from weather estimates to climate projections depends critically on how adaptation and cumulation are modelled. In the closely related temperature–mortality literature, Deschênes and Greenstone (2011) find that short-run weather estimates likely overstate the long-run costs of climate change, precisely because they do not fully account for adaptive behaviour. Whether the same holds for crime is an open empirical question.

Whether adaptation will attenuate the temperature–crime relationship in the long run remains an open question. In the temperature–mortality literature, Barreca et al. (2016) show that the diffusion of residential air conditioning essentially eliminated heat-related mortality in the United States over the twentieth century — a dramatic case of successful adaptation. Whether a comparable adaptation is possible for crime is less clear: the aggression and neuropsychological channels may be less amenable to technological mitigation than the thermoregulatory failures that drive heat mortality. Heilmann et al. (2021) provide suggestive evidence that the temperature–crime gradient is steeper in low-income neighbourhoods with less access to air conditioning, which is consistent with adaptation operating on the margin, but no study has directly tested whether the sensitivity of crime to temperature has changed over time. Clarifying the scope for adaptation — and, conversely, the risk of cumulation — is essential for translating the short-run estimates reviewed in this thesis into credible long-run projections of the social cost of climate change.

IV.4 POLICY IMPLICATIONS

IV.4.1 Climate change and public safety

If temperature–crime relationships are causal and stable, rising temperatures will increase criminal victimisation. Ranson (2014) projected an additional 22,000 murders by 2099. Heilmann et al. (2021) show that these effects will disproportionately affect low-income communities. Urban planners and law enforcement can use weather forecasts to anticipate crime spikes and allocate resources accordingly.

IV.4.2 Air quality regulation

The pollution–crime evidence implies that benefits of air quality regulations extend beyond health to include reduced criminal victimisation — a dimension not currently in regulatory impact analyses. Environmental justice is also relevant: pollution-burdened communities face both health and safety disadvantages.

IV.4.3 Recommendations for future research

Based on the gaps identified in this review, future research should prioritise: (i) multi-city panel datasets for generalisability; (ii) joint estimation of temperature and pollution; (iii) CFS data as an outcome measure; (iv) BLH as a globally available instrument for pollution; (v) nonlinear specifications for dose-response relationships; and (vi) hourly temporal resolution for more precise identification.

Each of these priorities is addressed by the panel dataset assembled during the internship that motivated this thesis. It combines roughly 59 million calls-for-service records from eight U.S. cities over 2018–2024 with hourly ERA5 temperature, hourly Boundary Layer Height, daily EPA air-quality measures, and gridded WorldPop population. Tab. IV.2 maps each gap identified in this review onto the specific feature of that dataset that addresses it, showing how the literature reviewed here translates into a concrete agenda for future empirical work.

Tab. IV.2 — How the internship dataset addresses the gaps identified in the review

Gap identified in the literature	Dataset feature addressing it
Single-channel estimation (heat or pollution, rarely both)	Weather (ERA5) and pollution (EPA) merged at a common spatial and temporal resolution, permitting joint estimation
Reliance on processed crime reports	~59 million calls-for-service records, capturing disorder and disputes largely absent from crime reports

Limited geographic coverage in the pollution literature	Eight U.S. cities spanning diverse climates and pollution regimes
Lack of a globally available instrument for pollution	Hourly Boundary Layer Height, a meteorologically driven instrument for surface pollution
Coarse temporal resolution	Hourly weather and BLH data, enabling fine within-day identification
Poorly characterised nonlinearity, especially for pollution	Fine variation in temperature and pollution across many city-days, supporting flexible dose–response specifications

CONCLUSIONS

This thesis has reviewed the empirical literature on the relationship between environmental conditions — ambient temperature and air pollution — and criminal activity. The evidence supports three main conclusions.

First, higher temperatures are consistently associated with more violent crime, and the better-identified studies support a causal reading. This is one of the more firmly established findings in environmental economics and criminology: across dozens of studies spanning multiple countries, decades of data, and diverse methods, hotter conditions are linked to elevated violent crime — particularly assault, domestic violence, and disputes. The estimated magnitude, on the order of 1–5% per °C above a comfort threshold, is large enough to carry meaningful policy implications, although individual estimates vary with specification. The relationship appears nonlinear, with the largest effects concentrated in the 30–35°C range.

Second, short-term exposure to air pollution is associated with more violent crime and disorder, with the quasi-experimental studies providing the strongest basis for a causal interpretation. A smaller, quasi-experimental literature finds that exposure to $PM_{2.5}$ and ozone raises impulsive violent crime, plausibly through neuroinflammatory pathways. Quasi-experimental designs typically estimate effects of 1–3% per standard deviation of $PM_{2.5}$, with instrumental-variable estimates exceeding OLS — a pattern consistent with attenuation from measurement error. That both channels affect impulsive, interpersonal crimes but not premeditated property crimes points to a common mechanism, reduced impulse control via impaired prefrontal-cortex function, even if that mechanism is inferred from behaviour rather than directly observed.

Third, important gaps remain. Most studies examine one channel without controlling for the other. Few use calls-for-service data. Geographic coverage is limited in the pollution literature. The joint, potentially interacting effects of heat and pollution are underexplored. Addressing these gaps requires multi-city panel datasets combining crime records with matched weather and air quality data — precisely the type of infrastructure constructed during the internship motivating this thesis.

The policy implications are significant. Climate mitigation and adaptation, air quality regulation, and urban planning all have unrecognised benefits — or costs, in the case of inaction — for public safety. Incorporating the environmental determinants of crime into policy analysis would lead to more accurate cost-benefit assessments and more effective public safety strategies.

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