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Post-pandemic crime trends in England and Wales

Hulya Seyidoglu^{1*} , Graham Farrell¹ , Anthony Dixon¹, Jose Pina-Sánchez¹  and Nick Malleson² 

Abstract

This study of recorded crime trends in England & Wales spans three and a half years, that is, two covid pandemic years from March 2020 and 18 'post-pandemic' months following cessation of covid restrictions. Observed crime rates were compared to expected (based on 5-year ARIMA models) and the ambient population (using Community Mobility Reports). It finds that, In Year 1, observed rates diverged dramatically from expected, waxing and waning generally in line with the movement restrictions of three national lockdowns. In Year 2, movement restrictions loosened and observed crime rates moved towards but mostly remained far from expected. In post-pandemic Year 3, people's movement increased and observed crime rates continued towards expected. By mid-Year 4 many rates remained below expected levels, their mean monthly differences including: theft from person (– 22%); burglary (– 20%); vehicle crime (– 29%); violence & sexual offences (– 27%); robbery (– 16%) and; public order offences (– 21%). An exceptional increase in shoplifting achieved 20% above expected rates by August 2023. Methodological limitations and further research on shoplifting and other issues are discussed. The main conclusion is that crime trends generally followed ambient population movement and that enduring lifestyle changes in the post-pandemic period, notably increased work-from-home, account for continuing below-expected rates of many crime types.

Keywords COVID-19, Forecasting, Lifestyle theory, Routine activities, Mobility theory, Ambient population, Shoplifting, Work from home

Introduction

Dramatic early-pandemic changes to crime rates are widely documented but analyses of post-pandemic effects are scarcer. Studies of pandemic crime and disorder change span various countries, problems and timeframes (Abrams, 2021, Andresen & Hodgkinson, 2020; Ashby, 2020a, 2020b; Borrión, et al., 2020; Buil-Gil et al. (2021); Carter & Turner, 2021, Chernoff (2021); Campedelli et al. 2020, Dai et al., 2021, Dewinter et al., 2021, Estévez-Soto, 2021, Felson et al., 2020, Frith et al., 2022, Gerell et al., 2020, Hodgkinson & Andresen 2020,

Johnson & Nikolovska, 2022; Kim & McCarty, 2021, Kozlarski, 2021, Lentz et al., 2022, Nivette et al., 2021, Payne et al. 2020, 2021, Piquero et al., 2020, Silverio-Murilla et al. 2023; Shimada et al., 2023, Wang et al. 2021). The present study spans two pandemic years from March 2020 plus 18 months post-pandemic in England & Wales for a total three and a half years, that is, of 42 months, to August 2023.¹ The 'post-pandemic' period is here defined as that since the cessation of all covid-related restrictions ('lockdown laws', detailed further below) on 24 February 2022. Trends in 13 recorded crime types and anti-social behaviour (ASB) are examined by comparing observed rates to those expected had the pandemic not occurred. The study's main contribution is to shed

*Correspondence:

Hulya Seyidoglu
lwhe@leeds.ac.uk

¹ School of Law, University of Leeds, Leeds, UK

² School of Geography, University of Leeds, Leeds, UK

¹ We use the ampersand to clarify that we refer to England & Wales as a single entity for present purposes, and that 'violence & sexual offences' and 'criminal damage & arson' both refer to single offence categories.



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Table 1 Lockdown law Timeline

Study Year	Date	Measures introduced
Year 1	Mar 2020	26 Mar: First national lockdown: schools and non-essential businesses closed except for essential shopping and 1-h per day local exercise. Facemasks and social distancing required in public space
	May 2020	10 May: People who cannot WFH return to work but not on public transport
	June 2020	01 June: Schools reopen. 15 June: non-essential shops reopen. 23 June: 2 m social distancing. 'Rule of six' outdoor meetings
	July 2020	04 July: Many restrictions removed (opening of pubs, restaurants, hairdressers). Outdoor gatherings up to 30 people allowed. First local lockdown (Leicester). August: 'Eat out to Help Out' hospitality subsidies
	Sept 2020	14 Sept: 'Rule of six' indoors and outdoors. 22 September: return to WFH; 10 pm curfew for hospitality sector
	Oct 2020	14 Oct: Three-tier area-based lockdown system
	Nov 2020	05 Nov: Second national lockdown. Schools and non-essential businesses closed. Meeting outdoor with one person outside 'support bubble' allowed
	Dec 2020	02 Dec: Second lockdown ends; return to three-tier lockdowns. 19 Dec: Four tier area-based lockdown system: 75% of country in tier 4 (the strictest) at turn of the year. 23–27 December: up to three households can meet up
	Jan 2021	06 Jan: Third national lockdown. Schools and non-essential businesses closed except for essential shopping. Support bubbles
Year 2	Mar 2021	08 March: Start of four-phase 'roadmap out of lockdown'. 08 March, Step 1: Schools reopen. 29 March, Step 1: Stay-at-home ends. Meetings of six people or two households allowed. Sports facilities reopen
	Apr 2021	12 April, Step 2: Many non-essential businesses reopen
	May 2021	17 May, Step 3: 30 people can mix outdoors; rule of six indoors; pubs, restaurants, cinemas reopen; up to 10,000 at outdoor stadiums
	June 2021	14 June: Step 4: restrictions on weddings and funerals abolished
	July 2021	19 July: most limits on social contact removed. All sectors of economy open including nightclubs
	Dec 2021	'Plan B' measures introduced due to omicron variant. 10 Dec: Facemasks required in indoor venues. 15 Dec: NHS covid pass required for specific settings like nightclubs
	Feb 2022	24 Feb: Remaining covid restrictions removed

preliminary light on new and enduring post-pandemic crime effects.

This study is underpinned by crime opportunity theory. A crime opportunity is defined as any situation in which the perceived benefits of committing a crime outweigh the perceived costs. Crime opportunity theory refers to the set of theoretical perspectives and frameworks with crime opportunity as the central construct. The most prominent are lifestyle theory, the routine activity and rational choice perspectives and the framework of situational crime prevention. Overlapping domains include problem-oriented policing, crime-prevention through environmental design and, more generally, environmental criminology and crime science (Wortley and Townsley 2017; Wortley et al., 2019). Most relevant here is the impact upon crime opportunities of changes to ambient populations (reflecting changes in movement of people) during the pandemic as a result of covid health policy and covid regulations. Legal restrictions reduced the flow and interaction of people in public places, thereby reducing crime opportunities for many crime types including around public transport, workplaces, retail and entertainment areas, while increasing surveillance and reducing some crime opportunities in residential areas. Conversely, the number of online crime opportunities increased as people moved online for shopping,

work and leisure activities (Buil-Gil et al., 2021, Johnson & Nikolovska, 2022; Stickle & Felson, 2020). In this way, ambient populations emerged as central to pandemic crime rate changes—rather than, say, the nature of offenders or victims, or the design of targets—such that one study offered a mobility theory of crime change in the pandemic (Halford et al., 2020).

Lockdown Laws

Table 1 summarises landmarks in 'lockdown laws', that is, covid-related legal measures, for England & Wales (Barber et al., 2021; Institute for government 2020).² A broad brush is used here for brevity. On 11 March 2020, the World Health Organisation pronounced a COVID-19 global pandemic. The first national stay-at-home lockdown began on 26 March 2020. Schools and non-essential businesses were closed, everyone except designated key workers was required to remain at home (aside from essential shopping and local exercise), and two metre social distancing was required. From 01 June, people were permitted to meet outside

² See also 2 Years of COVID-19 on GOV.UK—Government Digital Service (blog.gov.uk) at <https://gds.blog.gov.uk/2022/07/25/2-years-of-covid-19-on-gov-uk/> accessed 04 November 2023.

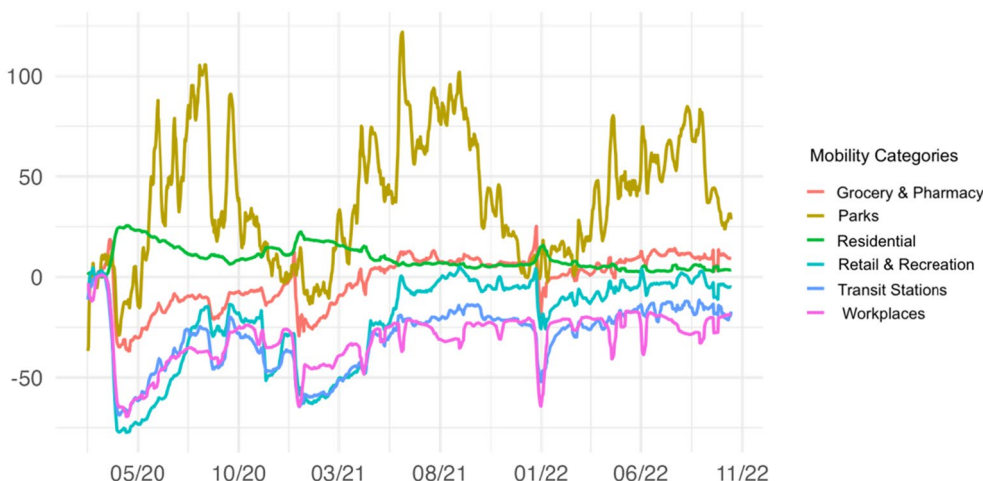


Fig. 1 Daily movement (mobility) trends, February 2020 to October 2023 (Source: Google COVID-19 Community Mobility Reports)

in groups of up to six (‘the rule of six’). Many lockdown restrictions were lifted between 04 July 2020 and 14 September, with outdoor gatherings of up to 30 people allowed. Public interaction was encouraged by subsidised pub and restaurant eating in August (‘Eat Out to Help Out’), with face masks mandatory in shops and supermarkets from 24 July. From 14 September 2020, restrictions were tightened as infection rates increased, with meetings of no more than six people indoors or outdoors. From 14 October an area-based tiered system was introduced which aimed to tailor lockdown restrictions to regional needs. The second national lockdown began on 05 November 2020, somewhat less restrictive than the first: schools, universities and colleges remained open, outdoor exercise was unlimited, and meeting outside with one person from outside the same household was allowed. Non-essential businesses closed, and meeting outside with one person outside the household or ‘support bubble’ was allowed. Restrictions on hospitality businesses were tightened from 02 December 2020 and the regional tiers system was modified from two to four tiers, intended to address the new Alpha covid variant. : Three-quarters of the country was under tier 4 (the strictest) at the end of the year. From 06 January 2021, the tiered system was abandoned, and a third national lockdown introduced. It was more similar to the first than second e lockdown, but allowed the formation of support bubbles and some specified small gatherings (such as small weddings). These restrictions define Year 1 of our study period: March 2020 to February 2021 inclusive.

From 08 March 2021, a four-step plan of exit from covid restrictions was introduced that ran through February 2022, defining Year 2 of the study (Table 1). All

covid restrictions were removed from 24 February 2022 so our Year 3 is March 2022 to February 2023, and our study includes the six months March to August 2023 inclusive which are termed Year 4 even though the year is incomplete.

Ambient population

Covid restrictions produced dramatic changes to ambient populations in different sectors of life. These are shown in Fig. 1 for six sectors using data from Google COVID-19 Community Mobility Reports which were available to 15 October 2022. Each line shows how ambient populations changed in comparison to the pre-pandemic baseline period (the median value for the 5 week period from January 3 to February 6, 2020). These mobility reports are imperfect measures and have been described previously



Fig. 2 Percent of adults working from home, 20 March 2020 to 5 February 2023. (Source: ONS 2023)

Table 2 Recorded crime and ASB categories

Crime Type	Description
All crime	Total for all categories
ASB	Individual, environmental and nuisance anti-social behaviour
Bicycle theft	Taking of a pedal cycle without consent or theft of a pedal cycle
Burglary	Entering a house or a building with the intention of stealing
Criminal damage and arson	Damage to buildings and vehicles and deliberate damage by fire
Drugs	Offences related to supply, possession, and productions of illicit drugs
Other crime	Forgery, perjury, and other miscellaneous crime
Other theft	Theft by an employee, blackmail and making off without payment
Possession of weapons	Possession of firearms or knives
Public order	Offences causing fear, alarm, or distress of public
Robbery	Using force or threat of force to steal
Shoplifting	Theft from shops or stalls
Theft from the person	Theft directly from victim without force or threat of force
Vehicle crime	Theft from or of vehicle or interfering in vehicle to steal it or items
Violence and sexual offences	Offences against person including assaults, bodily harm, sexual offences

Source: <https://www.police.uk/pu/about-police.uk-crime-data/>

in relation to the study of crime (Halford et al., 2020). They draw upon a limited amount of pre-pandemic data but offer valuable insight into aggregate changes in the movement of people.

Early in the pandemic, ambient populations declined between 60 and 70 percent around retail and recreation areas, workplaces, and transit stations (including train, bus and tram stations). With only essential shops remaining open there was a dramatic decline around grocery and retail areas but still less than elsewhere due to movement around those remaining open. Over time, population changes in these areas generally mirrored those of covid restrictions. Ambient populations increased as restrictions were eased, then declined in the second lockdown but not to the same extent. Each experienced a downward spike in January 2021 coincident with the third national lockdown. The trend in ambient populations around residential areas is an inverted version and less pronounced, residential populations varying with work-from-home (WFH, discussed below). By 2023, ambient populations around retail and recreation areas had largely returned to baseline levels, with that around grocery and pharmacy areas remaining above baseline. In contrast, movement of people around workplaces and around transit stations in particular, but also retail and recreation areas, remained well below baseline. These changes are revisited in the discussion.

Change in ambient populations around residential areas (and, conversely around workplaces and transit to some extent) can reasonably be inferred from WFH rates, shown in Fig. 2. Whereas 12 percent of British adults (1 in 8) reported working from home (at least once in the

past seven days prior to being surveyed) in 2019, this was 49 percent in the first half of 2020, 38 percent by mid-2022, and 40 percent in early 2023 (ONS 2023).³ Figure 2 shows WFH rates between 20 March 2020 to 5 February 2023, the most recent available at the time of writing.

Methods

Data

The primary data source of interest is open-source recorded crime data from data.police.uk for all police force areas in England & Wales except. Data was not available for one force which was Greater Manchester : "Due to a change in IT systems no crime, outcome or stop and search data is available from July 2019 onwards. The force is working to rectify this issue and provide the missing data over the coming months." (<https://data.police.uk/changelog/> accessed 04 November 2023). This should not greatly affect our findings and conclusions. The 13 recorded crime types and ASB are described in Table 2.

Police-recorded crime data are affected by selection biases that reflect variation in reporting and recording (Bottomley & Pease, 1986, Buil-Gil et al., 2022; Hart & Rennison, 2003, Pina Sanchez et al. 2022, 2023, Schnebly, 2008, Tarling & Morris, 2010). From 2014,

³ The ONS data refer to Britain. By 2023, workers in Scotland worked from home slightly more (59%) than England (56%) or Wales (58%), but there is no detrimental affect to the present study as Scotland accounts for less than 10% of Britain's population.

police-recorded crime rates in England & Wales were no longer designated as National Statistics “due to concerns about the quality and consistency of police crime recording practices.” (OSR 2023), while in 2023 the Office for Statistics Regulation observed that “[p]olice recorded crime statistics are a reliable measure of trends for some types of crime.” (OSR 2023) and the dramatic early-pandemic declines in many recorded crime rates described herein and elsewhere were found to be broadly consistent with those identified by the Telephone CSEW (ONS 2020a). More generally, if reporting and reporting practices remain constant, then trends in recorded crime can be informative. Moreover, for present purposes, the key issue is not the fit between recorded and CSEW trends but, rather, is the similarity in divergence between their observed and expected (forecast) rates. This and other issues are discussed in the limitations section below, and the general approach here is to promote methodological transparency such that the work can be replicated and critiqued.

Models

This study uses ARIMA models to forecast the rate of crime that would be expected in the absence of a pandemic. Recorded crime data spanning five pre-pandemic years (March 2015 to February 2020) was used to train models from which expected rates from March 2020 were estimated. ARIMA models draw on the long-term and seasonal variations in data to forecast the future trend, and the likely accuracy (which reflects past variation and unpredictability in the data) is gauged via confidence intervals (CIs). ARIMA models have been used previously to forecast expected crime rates in the pandemic (e.g. Ashby, 2020a, 2020b; Halford et al., 2020, Miller et al., 2023, Payne & Morgan, 2020, 2021, Rashid, 2021). The present study extends a study of the first 6 months of the pandemic (Langton et al., 2021) and issues of the *COVID-19 Statistical Bulletin* series of 2-page briefings (Seyidoglu et al., 2023). The ARIMA models used the forecast package in R. For readers interested in the technical details, the ARIMA pdq information is in this footnote.⁴

Due to the ready availability of extensive details on ARIMA as used here, to which readers are encouraged to refer, the topic will not be rehearsed in detail here. The ARIMA-specific methodological texts of most direct

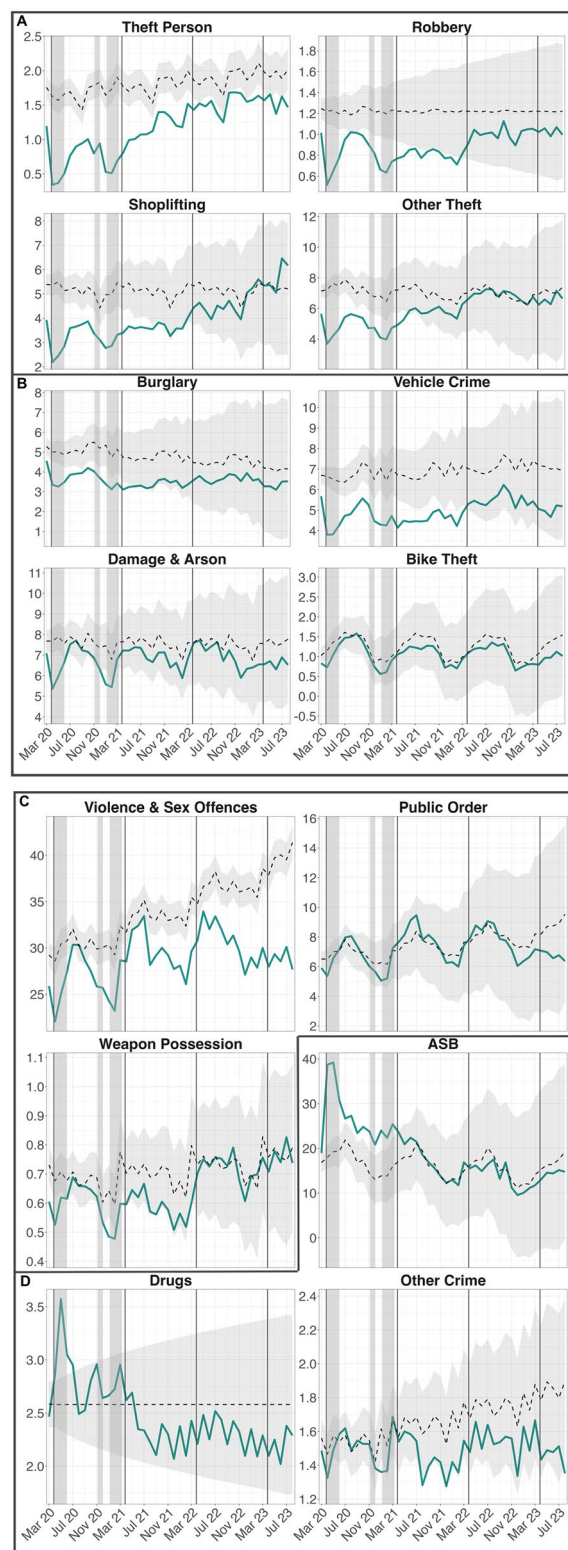


Fig. 3 Recorded crime rates (solid) and expected rates (dashed) with 95% confidence intervals (shaded), England and Wales, March 2020 to June 2023

⁴ Theft person (1,0,0)(1,1,0); Robbery (0,1,1)(1,0,0); Shoplifting (2,1,0)(1,1,0); Other theft (3,1,0)(1,1,); Burglary (0,1,1)(1,1,0); Vehicle crime (1,1,0)(1,1,0); Damage & arson (0,1,1)(0,1,1); Bike theft (0,1,0)(0,1,1); Violence & Sex offences (1,0,0)(0,1,1); Public order (0,1,0)(0,1,1); Weapon possession (0,1,1)(1,1,0); ASB (1,1,0)(1,1,0); Drugs(0,1,2)(1,0,0); Other crime (0,1,1)(0,1,1).

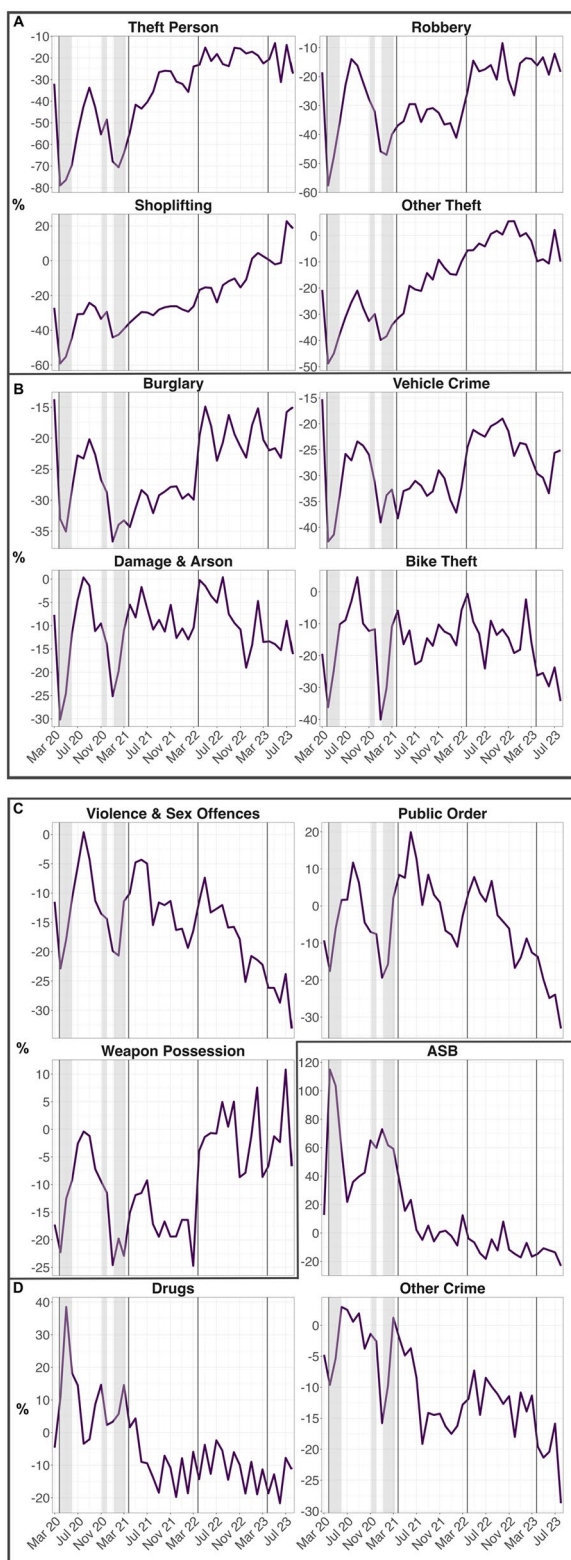


Fig. 4 Percentage divergence of observed (solid) from expected (zero) rate, England and Wales, March 2020-June 2023

relevance are those of Hyndman & Khandakar (2008) and Hyndman & Athanasopoulos (2021).

Findings

How findings are presented

Figures 3 and 4 show the main findings. Each has 14 facets comprising the 13 crime types plus ASB by month for March 2020 to August 2023. Our study are separated by vertical lines, two right-side sectors being those we consider as post-pandemic. Shaded vertical blocks in Year 1 show three national lockdowns.

Figure 3 shows crime rates per 10,000 population as a solid green line and the expected rate as a dashed line for March 2020 to August 2023 inclusive. The 95 percent confidence intervals around the expected rate are shaded.

Where the observed rate (solid line) falls outside the shaded area there is a statistically significant difference between observed and expected rates. Note that there is considerable variation in the CIs between and within facets. Key determinants of this variation are the volume of available data and the extent of variation within the training period. Forecasts further in the future produce wider confidence intervals around the expected crime rate (meaning the CIs expand over time), and this is a topic we return to in the discussion.

Figure 4 shows the percentage difference between the observed and expected rates as a solid line. If the observed and expected rates were the same then the difference would be zero, and to provide a visual reference point there is a horizontal line at zero. CIs are not shown in Figure 4 as they would be a transformed version of those in Fig. 3, as their exclusion allows the percentage difference to be shown more clearly (when included they tend to squash some of the facets vertically).

In Figs. 3 and 4, panels are grouped together into crime types that tend to occur more in particular areas (though many occur in multiple types of area), denoted as groups A to D (shown in Table 3). This draws on the comparisons used by Halford et al. (2020) and facilitates comparison with the COVID-19 Community Mobility Reports. Group A comprises theft from the person, robbery, shoplifting, and other theft, which are more likely to occur around retail, entertainment, public transportation and the workplace. Group B comprises burglary, vehicle crime, damage and arson, and bike theft that are more likely in residential areas. Group C comprises violence & sex offences, public order offences, and weapons offences which are more likely to occur in entertainment areas such as pubs, bars and clubs, and other public spaces. Group D is a catch-all for the remainder which are ASB, drug-related offences, and the category ‘other crimes’. Group D is included to be comprehensive, as it would be

Table 3 Grouped crime and ASB categories

Group		Crime types
A	Property crime around retail and entertainment areas	Theft person, robbery, shoplifting, other theft
B	Property crime around residential areas	Burglary, vehicle crime, criminal damage & arson, bicycle theft
C	Violence and public order	Violence & sexual offences, public order, weapon possession
D	ASB and miscellaneous	ASB, drug offences, other crime

stranger to exclude these categories, but they are not our primary focus (which is justified below).

Table 3 shows mean monthly percentage difference between observed and expected crime rates for study Years 1 to 4 (where Year 4 includes 6 months to August 2023). With 13 crime types plus ASB across four study years that include different permutations of covid restriction, the description of findings below is brief, and readers are encouraged to scrutinise the figures and table for further specifics. The discussion section offers a preliminary comparison and interpretation of the crime rate findings in the context of the ambient population data.

Year 1

Crime rates and ASB changed dramatically and generally in line with the three national lockdowns. The theft-related crimes in Group A exhibited sharp declines during the first national lockdown, waxing and waning with the less restrictive second and restrictive third national lockdowns. The property crimes in group B followed similar trends to group A but generally with less pronounced variation. Bicycle theft declined less than the others, generally tracking close to expected rates across the study period. Declines in public order offences were less pronounced, likely reflecting some breaches of covid regulations being recorded in this category. In group C, violence & sexual offences followed a similar general pattern to group A crimes, declining sharply then increasing, particularly in the August 2020 'Eat Out to Help Out' subsidised hospitality period which encouraged people to interact in and around bars, pubs, and restaurants.

Across Year 1, the mean monthly decline in recorded theft from the person was the greatest (– 56%), with all of group A crimes at over a one-third reduction (Table 4). Vehicle crime and burglary fell by over a quarter on average but had declined far more than this during lockdown periods. Weapons offences declined during the lockdown periods to between a fifth and a quarter below expected levels, averaging an 11 percent decline on expected in the first year.

ASB and drug offences increased in Year 1. The ASB spike in first lockdown was because breaches of covid restrictions were often recorded as ASB, this returning to

expected levels in Year 2 as the relevant regulations largely ceased (Halford et al., 2022). Drug offence increases were attributed to increased police stop and search early in the pandemic when street drug dealing was conspicuous on deserted streets Neanidis and Rana (2023).

Year 2

In pandemic Year 2 from March 2021, group A crime rates moved gradually back towards, but remained below, expected levels. Violence & sexual offences increased but remained well below expected levels, while burglary and vehicle crime remained relatively stable and moved in parallel with, but well below, expected levels. Across Year 2, theft from the person remained furthest below its expected rate as gauged by mean monthly difference (– 38.1%) with robbery, shoplifting, burglary and vehicle crime all close to one-third below expected levels (Table 4).

Post-pandemic years 3 and 4

Shoplifting was exceptional in Years 3 and 4. It increased across Year 3 but did so sharply later in the year, reaching expected levels for the first time. Shoplifting averaged 6.8 percent above its expected level in study Year 3 (Table 4), but that average masks the continued upward trend: July was 23% and August 19% above expected levels (Fig. 4).

Other theft increased at the end of Year 2 and ran close to expected levels throughout Years 3 and 4 but not with the dramatic and continuing change of shoplifting. In contrast, other crime rates were stable or decreased moderately relative to expected. Theft from the person, robbery, burglary and vehicles crime averaged around 20 percent below expected across Year 3, with violence & sexual offences 15.8% below expected. In Year 4 violence & sexual offences showed a relative decline (to a monthly average – 26.7% below expected), as did vehicle crime (– 28.5% average). Weapons offences, which had a monthly average of 16 percent below expected in Year 2, largely returned to expected levels as soon as covid restrictions were removed, and tracked expected levels across the 18 months that followed (Table 4).

Table 4 Mean monthly percent difference between observed and expected crime rates

Group	Crime Type	Year 1 (March 2020-)	Year 2	Year 3	Year 4 (6 months)
A	Theft from person	-56.1	-38.1	-19.5	-21.6
	Robbery	-32.3	-34.7	-19.3	-15.6
	Shoplifting	-37.3	-30.2	-12.9	6.8
	Other theft	-33.1	-19.9	-1.2	-6.5
B	Burglary	-27.1	-30.1	-19.9	-19.7
	Vehicle crime	-30.3	-33.2	-23.1	-28.5
	Crime damage & arson	-13.3	-8.8	-7.2	-13.5
	Bicycle theft	-16.8	-14.5	-11.8	-25.8
C	Violence & sex offences	-12.7	-11.5	-15.8	-26.7
	Public order	-5.5	3.2	-2.7	-21.3
	Weapons possession	-11.5	-16.3	-2.6	-2.5
D	ASB	57.4	10.2	-7.5	-15.2
	Drug offences	8.9	-7.8	-10.1	-14
	Other crime	-3.7	-10.8	-12	-19.6

Discussion

The changes in the crime rates are the main findings of the study. This discussion includes a preliminary comparison to changes in covid regulations and the resulting changes in ambient populations, and interpretation in the context of the theoretical foundation of the study. General patterns are discussed first.

Interpretation of findings

Year 1 crime rate changes generally tracked the three national lockdowns and the ambient population measures in duration and intensity. The sharp declines in populations around workplaces, public transport and retail & recreation areas, and to a lesser extent grocery & pharmacy (Fig. 1), were mirrored in decreased personal, property and public order offences: there were few people in these areas to act as either potential targets or offenders. Burglary and vehicle crime declines were consistent with the increased ambient populations providing informal surveillance in residential areas (Fig. 1) as indicated by increased WFH (Fig. 2).

Changes in Year 2 were largely consistent with Year 1 in terms of the relationship between ambient population and crime rates in different walks of life. The incremental relaxation of covid restrictions with the implementation of the four-step roadmap out of lockdown (Table 1) gradually increased ambient populations in the spaces where many personal crimes take place. More stable rates of burglary and vehicle crime across the study period are generally consistent with continuing higher WFH rates.

In Years 3 and 4, following cessation of covid restrictions, ambient populations in public spaces continued to increase (Fig. 1) but remained below pre-pandemic

baseline levels. Similarly, many crime types remained well below expected levels across the 18 month post-pandemic period examined here, consistent with ambient populations below pre-pandemic baseline levels around public transport and workplaces (Fig. 1), and with WFH continuing at around three-times the pre-pandemic level (Fig. 2). These indicators are consistent with continuing reduced numbers of people as potential targets and offenders in many public spaces and with continuing higher levels of guardianship in residential areas.

Bicycle theft was an exception. It did not decline as much as other property crimes in the pandemic, reflecting increased use and demand for bicycles during lockdowns due to proportionally greater local movement and exercise close to home (Harrabin, 2020; Vandy, 2020). Increased demand for bicycles plus supply-chain slowdowns stimulated prices (Witts, 2021) and theft, consistent with price-theft theory (Sidebottom et al., 2014). These factors meant bike theft returned to near-expected rates more quickly than other property crimes. That the expected rate was not exceeded is consistent with the downward pressure on property crime in public spaces of reduced ambient populations. In 2023, bicycle theft declined relative to the expected rate, consistent with cars being increasingly preferred over public transport, leading to reduced demand and excess bicycle stocks (Witts, 2023).

The anomalous surge in shoplifting in 2023 generated considerable media interest (BBC, 2022, 2023, Economist 2023, Gill, 2023, Kataria & Anderson, 2023, Fuller, 2023, Nanji & Calcea, 2023, Roberts, 2023). It was variously represented as due to the contemporaneous 'cost of living crisis', organised shoplifting, and limited police

responses (Farrell and Armitage 2023). A parsimonious interpretation in the present context would be that much of the increase is consistent with the relatively rapid rate at which returned to shopping areas which meant ambient populations around grocery and retail areas rose returned to, and exceeded, pre-pandemic levels (Fig. 1). Further research is required to explore this conjecture and identify potential means of developing efforts to improve the prevention of shoplifting.

Limitations and further research

The main limitation of recorded crime data is that it under-estimates actual crime rates and may contain other errors. The Crime Survey for England and Wales overcomes many reporting and recording problems but is less timely and has smaller sample sizes for month-by-month analysis by crime type. Continuing efforts to improve police crime recording practices include the National Crime Recording Standard (Home Office, 2023). The key issue for present purposes is not so much under-reporting and -recording but whether these vary over time. If a 5 year recorded crime trend varied from its corresponding CSEW trends, this does not necessarily mean the analysis of forecast change in recorded crime during the pandemic is misleading. For example, recorded violence increased in the pre-pandemic period but the CSEW found that by September 2019 the estimate of violent incidents "has not changed significantly since the year ending March 2015." (ONS 2020a; 7). Other things equal, the estimated pandemic and post-pandemic effect from both sources could be the same because the ARIMA model controls for trends. It is an empirical issue worthy of further research. However, the significant and increased divergence of violence from expected trends by Year 4 warrants further investigation. Omitted variable bias is a possibility to be acknowledged, and the influence of changes to policing practice upon crime rates has been suggested in some recent research (Fleming & Brown 2023, Lum et al. 2022).

Crime and ambient population trends were assessed based on visual comparison of key trends. There is a need for in-depth analysis of the relationships. Future work might gauge more precisely what change in mobility and ambient population produced what change in crime rate, and the extent to which this varied by stage of the pandemic. Halford et al. (2020) estimated the mobility elasticity of the crime rate for different crime types, and further work along those lines or using other analytic approaches might be appropriate. A limitation of the Community Mobility Reports is the broad nature of the six area-types into which all movement is grouped, and alternative sources might be explored.

The expansion of the CIs over time in Fig. 3 meant that even quite large post-pandemic differences between observed and expected were unlikely to be statistically significant for many crime types with the exception of theft from the person and violence & sexual offences. However, it appears that generally the ARIMA forecasts retain considerable utility. Consider that bicycle theft and ASB moved relatively quickly back to expected levels then, for the duration of the study period they their expected rates uncannily well (Fig. 3). For those crimes that continued some distance from expected levels, seasonal variations generally tracked well while the differences between observed and expected made sense overall in the context of relevant regulatory and ambient population changes, as discussed. That is, the differences fit with the other evidence and the theory. Overall, then, the ARIMA models appear robust for present purposes, perhaps surprisingly so for 42-month forecasts based on 60 months of training data. We suggest that, at minimum, the evidence presented here is sufficient that the burden is now on others to offer counterevidence or more compelling evidence of alternative findings and interpretation.

Conclusion

Early in the pandemic, one study speculated that "a post-pandemic era seems unlikely to see crime return to the levels expected absent a pandemic. With mobility a key determinant of crime opportunity rates, if 'work at home', online shopping and other lifestyle changes continue at higher rates, we might expect commensurate effects upon crime in the longer-term." (Langton et al. 2021; 13). The present study sits well with that statement. It finds the effects of the covid pandemic upon crime in England & Wales extended beyond the duration of covid regulations which ceased on 24 February 2022 &. Before the removal of all restrictions, crime and ASB rates were moving back towards the rates expected had the pandemic not occurred. Three and a half years after first lockdown, changes in crime rates proved generally consistent with changes in covid regulations and ambient populations. By mid-2023, many crime rates remained below levels expected based on pre-pandemic rates. This likely reflects enduring lifestyle changes, most notably continuing higher WFH rates. The anomalous spike in shoplifting requires further research. These conclusions are preliminary and indicate the need for further research on the topic generally, but they are otherwise consistent with crime opportunity theory and a mobility theory of crime in the pandemic.

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Author contributions

HS was responsible for the main text, generated visuals, and undertook data analysis. Anthony Dixon contributed by writing R codes. JPS, NM, and GF provided supervision, reviewed, and edited the process. All authors read and approved the final manuscript.

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Availability of data and materials

The crime data and mobility data used in this study are publicly available and retrievable. The crime data was obtained from the open online data portal for England, Wales, and Northern Ireland. The mobility data, on the other hand, was obtained from Google Mobility Reports.

Declarations

Competing interests

The authors declare that they have no competing interests.

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