Aix-Marseille-University

Aix-Marseille-Shool of Economics

Econometrics project

THEME: Analysis of determinants of crime in the USA and France.

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SUMMARY :

ABSTRACT

This research aims to identify the socio-economic factors influencing crime in France and the United States. We used a fitted linear model to analyze these relationships. Our findings, based on data from 1990 to 2022, indicate that the level of crime in these two countries is significantly influenced by several key variables, including GDP per capita, the Gini index (which measures economic inequality), the unemployment rate, the male proportion of the population, and the urbanization rate. These findings provide insight into the economic and demographic factors that contribute to crime rates.

INTRODUCTION

The international commitment to peace and security is reflected in multiple initiatives aimed at reducing violence around the world, such as the UN Sustainable Development Goals (SDG 16), the National Strategy for Prevention of Crime in France (2020-2024), and the United Nations Convention against Transnational Organized Crime in New York. However, despite these efforts, acts of violence continue to occur, particularly in major nations such as France and the United States. Recent incidents, such as the stabbing attack at a school in Arras (10/14/2023) and the shooting on the University of Las Vegas campus (12/06/2023), are striking examples.

It is notable and concerning that in 2023, incidents as serious as homicides will frequently occur in urban centers, causing considerable loss of life. With a global average of 440,000 homicide cases between 2019 and 2021, compared to 22,000 for terrorism and 94,000 for conflict, homicides are among the most prevalent forms of crime (2019 United Nations Office on Drugs and Crime (UNODC) . This reality is particularly tangible in countries like France and the United States, where incidents of violence such as bomb threats, attacks and homicides have increased significantly (more than 1,000 security alerts). bomb since September).

In France, for example, all crime indicators, with the exception of violent unarmed robberies, recorded an increase in 2022, with a 9% increase in homicides after an already worrying increase of 7% in 2021. United States, this worrying trend is also observable in certain states, notably in Washington DC Between January and August 2023, the federal capital recorded 166 homicides, an increase of 27% compared to the same period in 2022. These figures demonstrate of growing concern among citizens and public safety experts. The alarming development makes the analysis of the underlying factors of crime in these two countries particularly relevant.

In this study we observe the socio-economic determinants of crime in France and the USA, in order to identify the variables which can promote crime.

I.   Literature review:

The economic analysis of crime has captivated the attention of many researchers, who have explored its diverse causes and effects through a variety of approaches and methodological frameworks. One of the pillars of this literature is the work of Gary Becker, whose theory, presented in " Crime and Punishment : An Economic Approach » (Becker, 1968)revolutionized the way we perceive crime. Becker treats crime as a calculated choice, where individuals weigh the benefits and risks of their illegal actions. This approach, which places crime in a utility maximization perspective and highlights the deterrent role of legislation and the probability of arrest, has profoundly influenced the economic understanding of crime.

Studies (Winter-Ebmer, 2001)in " Identifying the Effect of Unemployment on Crime" (2001) found a positive correlation between unemployment and certain types of crime. Likewise, the impact of economic inequality on crime, studied by (Pratt, 2001)in " Reconsidering the Relationship Between Inequality and Crime", showed that inequality has little influence on property crimes but has a significant impact on violent crimes. Poverty and the effectiveness of police forces have a notable effect on property crimes, but less on violent crime, suggesting that the former aligns better with the economic theory of crime, while the latter fits more with theories of social tension and community disorganization.

The impact of public policies in combating crime has been widely examined in the academic literature. The study (Levitt, 1997), " Using Electoral Cycles in Police Hiring to Estimate the Effect of Police on Crime," highlighted the critical importance of investing in policing and the justice system to reduce crime. This research notably revealed a tendency to intensify police recruitment during electoral periods, both municipal and government. Furthermore, it has been observed that increasing police numbers contributes significantly to the reduction of violent crimes, although its effect on minor crimes is relatively moderate.

Recent studies have also explored the subject of crime from an economic perspective. For example, in "The impact of the economic condition on crime", (Gnaba, 2022)examined how economic conditions affect crime, using a linear model to illustrate that factors such as the economic cycle, the proportion of young men and the history of crime have a positive impact on crime, while income level, drug seizures and belonging to a Latin American country do not present a significant effect. Complementing this perspective, (Selim, 2017)analyzed data from the EU-28 and Turkey using a negative binomial fixed effects model. They conclude that variables such as GDP per capita, inflation, unemployment rate, urbanization and

overpopulation increase the crime rate, while increasing the recruitment rate and the number of police officers contribute to reduce it. Additionally, Cerulli , Ventura and Baum, in "The Economic Determinants of Crime: an Approach through Responsiveness Scores", applied responsiveness scores to assess the impact of different socio-economic factors on crime in 50 US states, revealing varied responses and trends depending on the type of crime and empirically confirming several major economic theories related to crime. Together, these three studies provide an in-depth and nuanced view of the various economic and demographic determinants of crime, despite their methodological and geographic differences.

II. Data presentation:

1. Sources:

The creation of our database was based on a rigorous collection of information from leading institutional and specialized sources, such as the World Bank, the National Institute of Statistics and Economic Studies (INSEE), Organization for Economic Cooperation and Development (OECD), Statistica , Actualitix and Politologue, as well as the Crime Data Explorer of the Federal Bureau of Investigation (FBI). Our data corpus encompasses a detailed time series spanning from 1990 to 2022, focused on the socio-economic and criminal analysis of two nations: France and the United States. Our database, comprising 66 observations spread over two countries and covering 33 years, meets the essential criteria for a reliable estimation of the model used. According to the principle stated by Central Limit Theorem (CLT), to achieve adequate statistical power and ensure the robustness of the results, the number of observations (n) must be greater than 30. In our case, this condition is satisfied, which reinforces the validity of our analysis. However, it should be noted that, despite this compliance with the basic requirements of the CLT, the inclusion of additional data and a diversification of observations could help to further refine our results and deepen our understanding of the socio-economic determinants of crime .

2. Variables used:

The variables selected for this research were determined from a literature review , drawing on previous studies and established theoretical frameworks in the area of socioeconomic determinants of crime.

Criminal rate :

The crime rate is generally calculated as the number of offenses (crimes and misdemeanors) occurring during a given period compared to a reference population, often expressed per 100,000 inhabitants to facilitate comparison between different regions or periods.

Here is the standard formula for calculating the crime rate:

$$Taux\ de\ criminalité = \frac{Nombre\ total\ de\ crimes\ signalés}{Population\ totale} * 100\ 000$$

Another method to obtain the crime rate is:

$$Taux\ de\ criminalité = (\frac{V\ Cst}{Population\ totale} + \frac{P\ Cst}{Population\ totale}) * 100,000$$

With $V\ Cst = nombre\ de\ crime\ violent\ et\ P\ Cst = nombre\ de\ crime\ non\ violent$

Average salary: Data on average salary comes from the OECD website. For this organization, this indicator is calculated by dividing the total payroll from the national accounts by the average number of employees in the total economy, then multiplying the result by the ratio of the average number of usual weekly hours per employee full-time and the average number of weekly hours for all employees. This indicator is measured in US dollars at constant prices using the base year 2016 and purchasing power parities (PPP) for private consumption in the same year.

Employment rate: Data concerning the unemployment rate also come from the OECD website. This indicator is measured as the percentage of unemployed people relative to the active population and is adjusted for seasonal variations.

GDP per capita: This is the GDP at current prices in terms of purchasing power divided by the number of inhabitants. This information is provided by the OECD website.

Gini Index: According to the World Bank, the Gini index measures the extent to which the distribution of income (or, in some cases, consumer spending) among individuals or households within an economy deviates of a perfectly equal distribution. It varies between 0 (perfect equality) and 1 (extreme inequality). The higher this index, the greater the inequality. Data for the Gini index comes from the World Bank.

Urban population: This is the urban population as a percentage of the total population. These data are extracted from the World Bank databases.

Level of education: According to the OECD, this indicator assesses the educational level of adults, defined by the highest level of education attained by the population aged 25 to 64. There are three levels: below upper secondary, upper secondary and tertiary education. The indicator is measured as a percentage of the population of the same age. Data on education level are provided by the OECD.

Masculinity Rate: This is the number of male people as a percentage of the population. Information regarding this indicator comes from the World Bank website.

Working age population : This is the percentage of population aged 14 to 65. Data on this variable were obtained from the OECD website.

Abbreviations associated with each variable:

- g _mean : Average salary.
- gini : Gini index.
- unemp _rate : Unemployment rate.
- pop _male : Masculinity rate.
- urban _rate : Urbanization rate.
- niv _educ : Education level.
- wg _ag_pop : Population of working age

3. Data processing:

Concerning the procedure for imputation of missing data, several specific approaches were adopted for each variable in order to preserve the integrity and reliability of the information. For the variable ' Wg_mean ' (average wages), we used the imputation method by the following value, a technique commonly used to maintain the temporal consistency of data series. Regarding the 'unemployment rate', the missing data for the year 2022 were completed by referring to official communications from INSEE and Statistica . For the Gini index, a measure of economic inequality, we opted for imputation by the median, also using data communicated by INSEE and Statistica for 2022 for France and the United States, and for 2021 exclusively for France. Finally, for 'education level', imputation was carried out using the median, which helps to attenuate the impact of extreme values and provide a robust and representative estimate of the central tendency of this variable.

III.   Descriptive Statistics:

Between 1990 and 2022, France saw wages rise from \$39,639 to \$53,172 (US) and GDP per capita rise to \$45,516 (US), reflecting increased prosperity despite a median unemployment rate of 9,367 %. On the social front, the Gini index increased slightly, from 29.3 to 33.7, pointing to growing inequalities. However, advances in education, with almost 50% of the level achieved, and urbanization, indicate modernization and societal transformation. The

distribution by sex has remained constant around 48% male, while the increase in the population aged 16 to 65 (from 61.49% to 65.88%) suggests demographic aging. Finally, a notable increase in the crime rate, reaching a high of 6,893, highlights public safety challenges and calls for increased policy vigilance.

Table 1: Descriptive statistics for France 1990-2022:

France									
Variable	wage level (US dollards)	unemployement rate (%)	GDP per person (US dollars)	Gini index	urban_rate	Education level	Male level	Group_age _16_65	Crime rate
Min.	39639	7.100	21676	29.30	74.06	16.70	48.33	61.49	4925
1st Qu	42550	8.742	24288	31.60	75.42	22.68	48.38	63.21	5466
Median	47347	9.367	36470	32.05	77.38	30.97	48.45	65.02	6011
Mean	46766	9.684	33420	31.86	77.49	30.82	48.46	64.27	5962
3rd Qu	50581	10.350	40886	32.50	79.39	36.13	48.52	65.20	6347
Max.	53172	12.400	45516	33.70	81.51	49.47	48.66	65.88	6893

Source: Our own calculations, R software

In the United States, the period from 1990 to 2022 was marked by a booming economy, with increasing wages, reaching a peak of $78,894, and growing prosperity highlighted by a peak GDP per capita of $76,330. However, this economic growth was accompanied by a slight increase in inequality, with the Gini index increasing to 41.50. At the same time, education and urbanization have made notable progress, signs of urban modernization and the promotion of education. The distribution of the population by gender has remained constant, while the increase in the 16 to 65 age group indicates both a potential strengthening of the labor market and demographic aging. In terms of security, a peak in crime at 5,898 incidents signals challenges, but with a median of 3,826. These different indicators reflect a nation in full evolution, balancing economic growth and social issues.

Table 2: Descriptive statistics for USA 1990-2022:

USA									
Variable	wage level (US dollards)	unemployement rate (%)	GDP per person (US dollars)	Gini index	urban_rate	Education level	Male level	Group_age _16_65	Crime rate
Min.	52224	3.570	23889	38.00	75.30	8.158	48.96	64.83	2219
1st Qu	57637	4.617	32854	40.00	78.38	10.430	49.16	65.48	2936
Median	64945	5.533	46302	40.50	80.10	12.092	49.26	66.04	3826
Mean	64011	5.826	44958	40.38	79.80	11.995	49.27	66.12	3876
3rd Qu	68591	6.817	55124	40.90	81.48	13.545	49.41	66.78	4620
Max.	78894	9.617	76330	41.50	83.08	16.767	49.56	67.30	5898

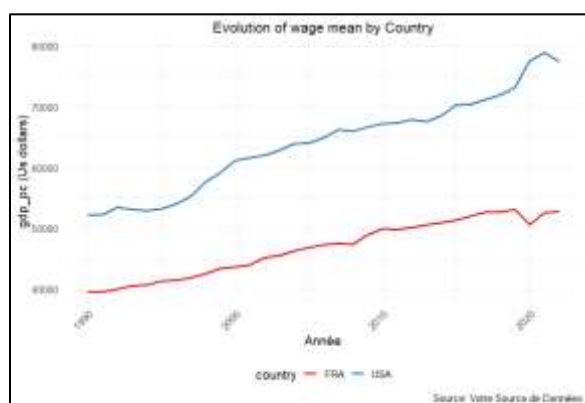**Source:** Our own calculations, R software

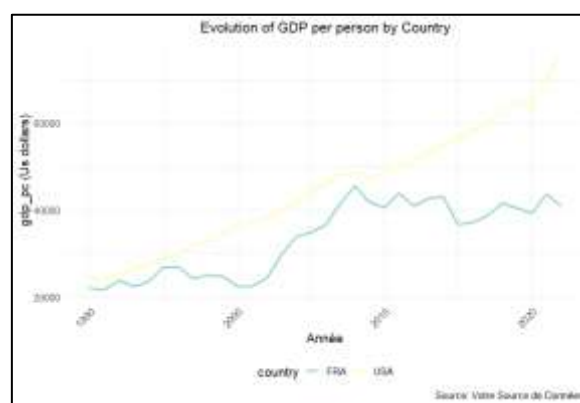Figure 1: Evolution of average salary 1990-2022

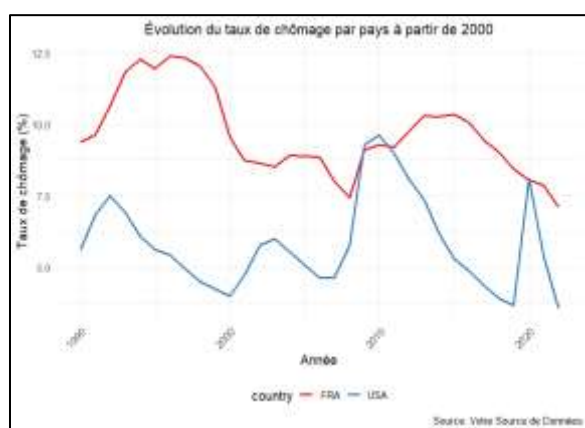Figure 2: Evolution of GDP per capital 1990-2022

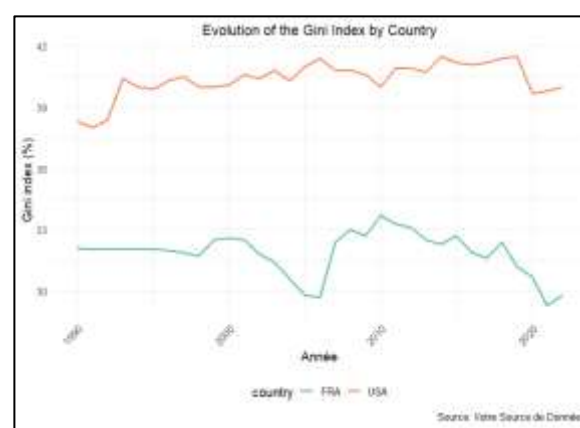Figure 3: unemployment rate 1990-2022

Figure 4: Evolution of the gini index 1990-2022

Source: Our own calculations, R software

Between 1990 and 2022, the average salary in France increased moderately from $39,638 to $52,763, while in the United States the growth was more pronounced, with salaries climbing from $52,224 to $77,463. This comparison highlights more robust wage growth in the United States compared to France over the period observed.

Between 1990 and 2022, the unemployment rate in France saw a decrease, from 9.37% to reach 7.1%, indicating an improvement in the job market over this period. In the United States, the unemployment rate has fluctuated more noticeably, starting at 5.62% in 1990, reaching historic lows in 2019 at 3.67% before rising to 3.57% in 2022, revealing market resilience of American work despite economic crises

GDP per capita in France experienced fluctuations during the period 1990-2022, starting at $21,865 and reaching $40,886, reflecting economic growth with notable variations. In the United States, the progression was more marked, with GDP per capita starting at $23,888 and

rising spectacularly to $76,329, underscoring a more substantial and consistent economic expansion compared to France.

For the Gini index, which measures economic inequality, France has seen a notable decrease since 1990, with the index starting at 32.1 and oscillating until reaching 29.8 in 2022, suggesting a reduction in inequality of income. In contrast, in the United States, the Gini index has remained relatively high and stable over the same period, starting at 38.3 in 1990 and rising slightly to 40 in 2022 after a slight decline, indicating persistent inequality that remain an economic challenge.

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Figure 5 : Distribution by area type
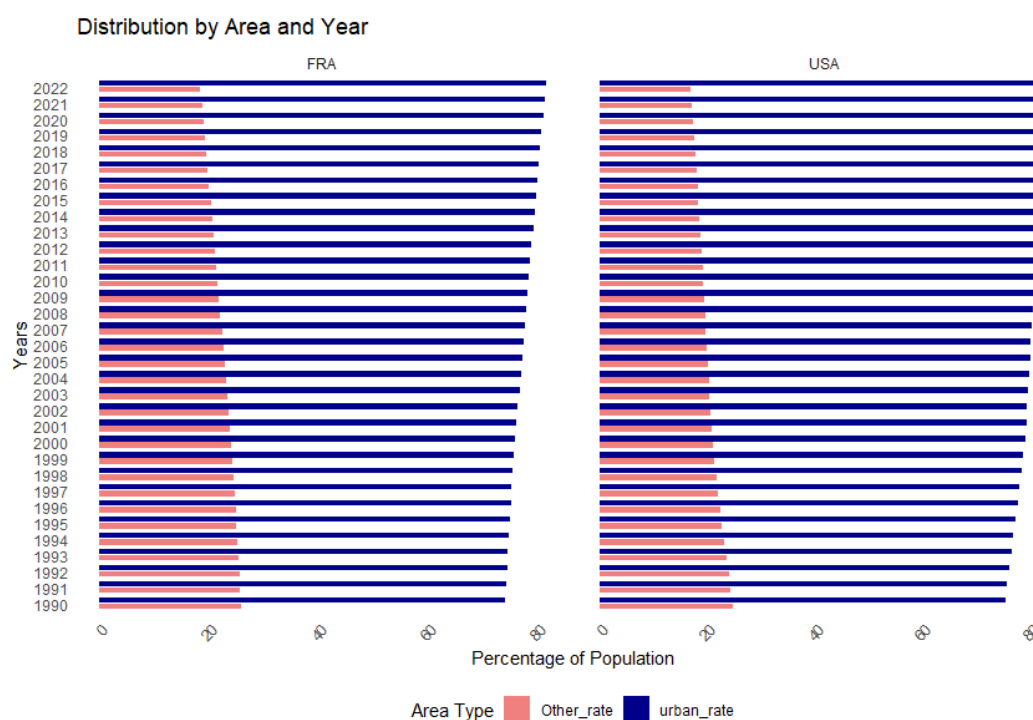
Source: Our own calculations, R software

Urbanization in France has seen a steady increase, from 74.056% in 1990 to 81.509% in 2022, demonstrating sustained growth in urban areas. In the United States, this trend is also observed, with an increase from 75.3% to 83.084% over the same period, indicating a slightly higher level of urbanization and a constant expansion of cities.

Figure 6 : Correlation plot
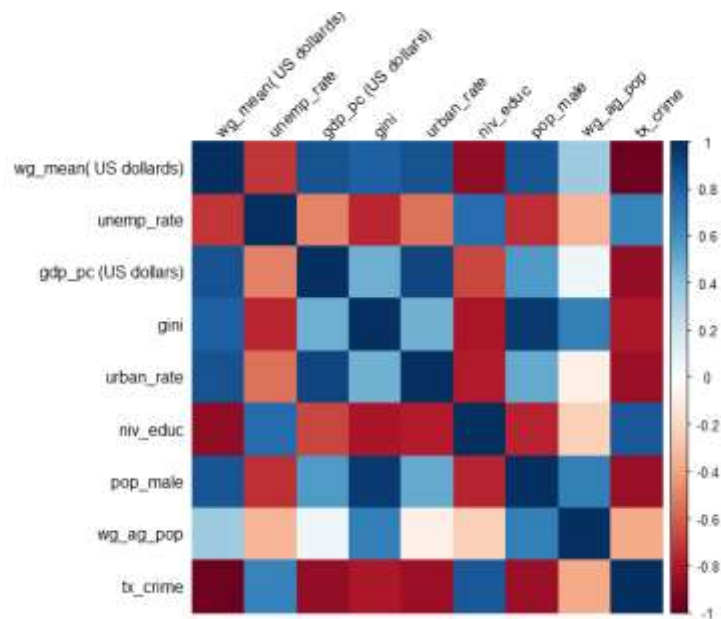
Source: Our own calculations, R software

The correlation matrix reveals that crime rate is strongly and negatively correlated with average salary (-0.977), indicating that higher salaries may be associated with lower crime rates. Additionally, there is a significant positive correlation between crime rate and education level (0.848), suggesting that higher education levels may coincide with increased crime, which may seem counterintuitive. and would require further analysis to understand the underlying factors. Furthermore, the crime rate also shows a strong negative correlation with GDP per capita (-0.876) and urbanization rate (-0.851), suggesting that stronger economies and higher urbanization rates could be linked to a drop in crime

IV.   Econometric model:

Individual effect test:

The null hypothesis tests whether all fixed effects are jointly zero, by comparing fixed effects estimates to those from OLS regression. The results indicate acceptance of the absence of

individual fixed effects. So the best estimator is the OLS one. The individual effect test, often performed using an F-test in the context of panel data analysis, is used to determine whether fixed effects are present in the data. The null hypothesis states that all individual effects are zero, suggesting that there are no significant differences between entities (such as countries or individuals) that would require a fixed effects model. The test compares the estimates from the fixed effects model with those obtained from ordinary least squares (OLS) regression. If the null hypothesis is not rejected, this implies that the fixed effects are jointly insignificant and an OLS estimator may be preferred due to its simplicity and efficiency.

In this specific case, the p-value of 0.214 from the F-test suggests that we do not reject the null hypothesis, indicating that there is no substantial evidence of individual fixed effects in the model. Therefore, the ordinary least squares estimator is considered the most suitable for this analysis .

Model used:

As part of this study, the initial estimation method was based on the ordinary least squares (OLS) model, designated here as model 1. However, the presence of heteroscedasticity , highlighted by the Breusch -Pagan test, forced us to reject the hypothesis of homoscedasticity inherent to this model. In order to overcome this heteroskedasticity , the use of White's robust variance-covariance matrix, representing model 2, proved necessary to obtain reliable and robust estimates to violations of the classic assumptions of the linear regression.

The model equation is therefore:

$$tx\_crime_{it} = b_1 + b_2\,gdp\_pc + b_3\,wg\_mean + b_4\,gini + b_5\,unemp\_rate + b_6\,pop\_male + b_7\,urban\_rate + b_8\,niv\_educ + b_9\,wg\_ag\_pop + u_i + \epsilon_{it}$$

Results

The analysis of the determinants of crime via OLS regression reveals significant relationships between GDP per capita, the unemployment rate, the proportion of the male population and the urbanization rate with the crime rate while the application of White's matrix to correct for heteroskedasticity reveals significant links between several variables and the crime rate. Note also that the explanatory power of our model expressed by the R2 is 0.978, reflecting a good level of regression.

```
===============================================================
                Dependent variable:
----------------------------
                       tx _crime
(MODEL 1) ( MODEL 2)
-------------------------------------------
gdp _pc -0.031***          -  0.026***
(0.007)                       (0.006)

wg_mean 0.025 _               0.006(
(0.020)                       0.017)

gini -45.185*                -55.276**
(26,087)                     (21.469)

unemp _rate -73.721***       -68.534***
(16,970)                      (13.966)

pop _male -1,618,665***      -1,367.915****
(310,234)                    (255.321)

urban_rate -248.491 ***      -242.999***
(51,537)                      (42.414)

niv _educ 5.755              -2.822
(7,725)                      (6.357)

wg_ag_pop -40.241 _           -32.363
(37,766)                      (31.081)

Constant 108,066,100***      96,248.180***
(16,830,920)                 (13,851.750)
-------------------------------
Comments 66 66
R2 0.982 0.978
===============================================================
Note: *p<0.1; **p<0.05; ***p<0.01
```

Source: Our own calculations, R software

A decrease of 0.026 points in the crime rate is associated with each unit increase in GDP per capita (gdp_pc), with a significance level p less than 0.01, highlighting a strong and significant negative relationship. Furthermore, an increase in the Gini index, which means an increase in income inequality of 55,276 points, is correlated with a significant increase in the crime rate at a significance level of 5%. Regarding demographics, a one-unit increase in the proportion of male population (pop_male) is associated with a significant decrease of 1,367,915 points in the crime rate, with a significance level p less than 0.01. This significant and negative relationship suggests that higher percentages of male population could be associated with reduced crime, which could reflect socio-cultural aspects or effective prevention policies. As for the urbanization rate (urban_rate), it shows a significant decrease of 242,999 points in the

crime rate for each unit of increase, which is very significant with a p level less than 0.01. This could indicate that urban areas, with their infrastructure and social services, can be better equipped to manage and prevent crime. Surprisingly, a one-unit increase in the unemployment rate (unemp_rate) is linked to a significant reduction of 68,534 points in the crime rate, with a significance level p less than 0.01. This result contradicts the usual hypothesis which postulates a positive correlation between unemployment and crime and may require further analysis to understand the underlying mechanisms. The estimates do not find statistical significance for the level of education (niv_educ) and the proportion of the population of working age (wg_ag_pop), with p-values of 0.459 and 0.291 respectively, suggesting that these variables do not have no clear or direct effect on the crime rate in this model. These results contrast with the OLS model where the significance of some variables was different, highlighting the importance of selecting the appropriate model for data analysis in the presence of heteroskedasticity .

In summary, the use of the White matrix reveals that GDP per capita, the Gini index, the unemployment rate, the gender ratio (male share) and the urbanization rate have a significant influence on the crime rates, with sometimes counterintuitive results such as the negative effect of unemployment on crime. These estimates, contrasting with those of the OLS model, highlight the importance of choosing an estimation method robust to heteroskedasticity to obtain reliable conclusions.

Comment :

In the context of economic theory, the negative association between GDP per capita and crime rate suggested by White's matrix aligns with the theories of Becker (1968), who posit that improving economic conditions reduces incentives to crime by increasing the opportunity costs associated with criminal activity. Furthermore, the significant relationship between the Gini index and crime corroborates the work of Kelly (2000), who argues that higher levels of inequality exacerbate social tensions and encourage criminal activity.

The counterintuitive link between unemployment rates and crime can be examined through the lens of Festinger's (1957) theories of cognitive dissonance, which could explain how disadvantageous individual circumstances do not necessarily lead to antisocial behavior if they are tempered by social safety nets or strong cultural values. The share of men in the population, being significantly linked to a reduction in crime, could reflect complex social dynamics which deserve a more nuanced analysis, potentially linked to theories of masculinity and crime.

Finally, the negative effect of the rate of urbanization on crime may contradict some traditional expectations that associate population density and crime (Shaw and McKay, 1942), suggesting that urban environments, with their resources and infrastructure, could actually play a preventive role against crime. These empirical results, based on methodologies robust to heteroscedasticity , offer an enriched perspective for the analysis of the determinants of crime in an economic framework.

Conclusion:

In this study we aimed to analyze the socio-economic determinants of crime in France and the USA. Through the analysis of data covering indicators such as GDP per capita, the Gini index, the unemployment rate, the male proportion of the population and the urbanization rate, we identified factors significantly linked to the levels of crime. Our results suggest a negative correlation between GDP per capita and the crime rate, while the Gini index, which measures inequality, presents a positive relationship with crime. Surprisingly, an increase in the unemployment rate seems to be associated with a decrease in crime, which requires further investigation to understand the mechanisms. The male proportion and the urbanization rate also turn out to be significant predictors. These findings open avenues for the development of targeted public policies and for future research that could explore in more detail the causal links and interactions between these variables.

Limit of the study:

Our research, although anchored in a methodical scientific approach, is not free from limitations, mainly due to the limited scope of the available data. Our database, comprising 66 observations for France and the United States over the period 1990-2022, has a restricted scale. It is plausible that more robust and explanatory conclusions could have been drawn from a larger data set

Recommendations:

In light of the results obtained, here are some strategic recommendations:

Investment in Economic Development: Given the negative correlation between GDP per capita and crime, it is advisable to invest in programs that stimulate economic growth. This may include initiatives to improve education, job training, and entrepreneurial innovation.

Reducing Inequalities: Given the significant relationship between the Gini index and crime, efforts must be made to alleviate economic inequalities. More equitable tax policies, income redistribution programs, and access to quality social services are measures to consider.

Unemployment Support Programs: The counterintuitive link between unemployment rates and crime suggests the need for support programs for the unemployed. These programs could include temporary financial aid, retraining, and employment counseling services.

Study of Gender Dynamics: The significant relationship between the proportion of male population and a decline in crime calls for a more in-depth analysis of gender roles in society. Educational programs focusing on gender equality and violence prevention could be beneficial.

Improvement of Urban Infrastructure: The preventive effect of urbanization on crime suggests the importance of investing in quality urban infrastructure. Efforts to improve street lighting, surveillance, access to recreation, and policing could help reduce crime.

Continued Research and Analysis: Finally, it is essential to continue research and analysis of the socio-economic factors influencing crime. The collection of detailed data and the implementation of robust analysis methods will help refine the understanding of these complex dynamics.

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