

Economic growth, income inequality and lethal violence in developed countries

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Abstract

Purpose – The paper aims to investigate the effect of GDP growth on crime and to test the hypothesis of nonlinearity. Additionally, we estimate the interaction between GDP and income inequality and examine its impact on the relationship between GDP and homicide rates.

Design/methodology/approach – The study utilizes panel data from the Organization for Economic Cooperation and Development (OECD), spanning the period from 2000 to 2018 and estimates dynamic panel GMM models.

Findings – We found a nonlinear relationship between GDP and homicide rates, indicating a dual effect of GDP on the occurrence of lethal crimes. Moreover, income inequality conditions the effect of GDP on homicide rates, exerting a significant influence. We conclude that in contexts characterized by high levels of income inequality, GDP growth is more effective in reducing crime, as there is greater potential for improvement.

Originality/value – This paper contributes to the existing literature by providing insights into the complex nonlinearity between economic conditions, income inequality and homicide rates.

Keywords growth, Development, Violence, Property, Crime

Paper type Research paper

1. Introduction

Rising levels of overall wealth, or economic growth, within a nation are beneficial for society as a whole, but this holds true only when accompanied by equitable income distribution.

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In the presence of structural income inequality, economic growth exacerbates or even gives rise to various social issues, including crime (Danziger & Wheeler, 1975).

Economic expansions and recessions significantly impact the well-being of individuals within society. From an economic standpoint, under the assumption that all other factors remain constant, expansion is typically associated with low unemployment, higher income levels, and improved living conditions, leading to a decrease in crime rates (Becker, 1968). In this perspective, there is an inverse relationship between GDP and crime. However, when considering income inequality, economic expansion can amplify feelings of frustration among marginalized groups, potentially leading to an increase in crime or violence (Danziger & Wheeler, 1975). This suggests the possibility of a non-linear relationship between economic growth and crime. Consequently, the role of income distribution becomes crucial in determining the impact of economic expansion on crime rates. To explore this relationship, this study employs homicide rates as a proxy for lethal violence due to their comparatively higher reliability and completeness in available data, in contrast to other types of crimes that are more prone to underreporting (Parker, 1985; Fajnzylber, Lederman, & Loayza, 2002).

The main objective of this study is to address gaps in the existing literature regarding the association between economic conditions, as measured by GDP, and homicide rates. Specifically, the study investigates the effect of GDP growth on crime and tests the hypothesis of non-linearity (U-shape). Additionally, this study examines the interaction between GDP and income inequality and investigates its impact on the association between GDP and homicide rates. The hypothesis posits that the effect of GDP on homicide rates varies based on levels of income inequality, leading to various scenarios of effect. Furthermore, the study assesses and discusses the effect of government expenditure on public safety, income inequality, alcohol consumption, and the percentage of youths Not in Education, Employment, or Training (NEET) on homicide rates. By pursuing these objectives, the study aims to contribute to the existing literature by providing insights into the complex relationship between economic conditions, income inequality, and homicide rates.

Regarding the main objectives, the hypotheses (H1 and H2) put forward are:

- H1. Homicide rates reduce as GDP increases (the economic hypothesis) but the opposite effect may occur as GDP increases in contexts of income inequality (the social structure hypothesis), consequently; and
- H2. There is an interaction effect between GDP and income inequality on the homicide rate, whereby the effect of GDP on homicide rates is conditioned to levels of income inequality.

In relation to other determinants, it is hypothesized that income inequality, the NEET population (youths not in education, employment, or training), and alcohol consumption are directly associated with crime. On the other hand, the association between government expenditure on public safety and crime is conceptually expected to be inverse. However, in practice, this association can be ambiguous due to endogeneity issues, as the government may allocate more funds to public safety when crime rates are high. To address this ambiguity, appropriate modeling methods and specification strategies are employed in the study.

A higher rate of criminality is not only more prevalent in developing countries compared to developed ones, but it also coexists with numerous other socioeconomic issues. This is particularly true for violent or lethal crimes, making it even more challenging to isolate the causal effect of economic conditions on these types of crimes. Hence, in this study, the focus is on developed countries where other socioeconomic conditions, such as poverty,

unemployment, and low educational attainment, are less pronounced. By examining the relationship between economic growth, inequality, and crime in this context, the study aims to better understand the specific impact of economic conditions on crime rates.

To test the hypotheses, data from member countries of the Organization for Economic Co-operation and Development (OECD) are utilized in this study. The OECD is a group consisting of 36 countries (as of 2019) with a shared objective of promoting economic progress, facilitating trade, and exchanging policy experiences to address challenges faced by its member countries. These member countries are typically classified as developed nations, characterized by high GDP and a high Human Development Index (HDI). Moreover, crime rates tend to be significantly lower in OECD member countries compared to other countries worldwide. For instance, in 2018, the average homicide rate within the OECD was approximately 2.25 per 100,000 population, which is considerably lower than rates observed in developing countries such as Brazil (31.6 in the same year, according to [IPEA-FBSP, 2019](#)). The use of OECD data is preferred due to its reliability and comprehensive nature, providing a robust foundation for analyzing the relationship between economic conditions, inequality, and crime in developed nations.

The OECD member countries are namely, Australia, Austria, Belgium, Canada, Chile, Czech, Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States. Brazil is not yet a member country, although it is on the list of potential countries that may join the OECD.

While the member countries of the OECD share common development goals, it is important to recognize that they differ in terms of culture, institutions, and geography, which may also influence criminal behavior. Furthermore, these countries exhibit significant variation in levels of lethal crimes. On one hand, there are countries with notably high homicide rates, such as Mexico, Estonia, Latvia, and the United States. On the other hand, there are countries with very low rates, such as Norway, Denmark, Luxembourg, Austria, and Iceland. This heterogeneity, coupled with the availability and reliability of panel data, makes the OECD group an appealing case for testing the hypotheses of this study. The empirical strategy employed allows for the exploration of diverse contexts encompassing crime, GDP, and inequality levels within the OECD. As a result, the findings and contributions of this study can be extended to a wide range of international contexts.

This study is structured into five sections. The next section reviews the related literature, detailing the links between economic conditions and crime. [Section 3](#) provides an overview of the data source, empirical modeling, and procedures used in the study. The results are reported and discussed in [Section 4](#). [Section 5](#) concludes the study.

2. Related literature

The relationship between economic conditions and crime is formally established in [Becker \(1968\)](#) and extended by [Danziger and Wheeler \(1975\)](#) to address the effect of income inequality on this relationship and crime itself.

The classical school of criminology posits that decisions to commit crimes are rational, intelligent, hedonistic, and self-determined ([Beccaria, 1764](#)). This perspective, central to [Becker's \(1968\)](#) economic theory of crime, suggests that crime results from conscious choices based on a cost-benefit analysis. A crime is committed only when the perceived benefits outweigh the costs and the benefits from legal income sources. This theory has been applied to understand individual economic motivations behind criminal behaviors ([Danziger &](#)

[Wheeler, 1975; Sullivan, 1973](#)) and sustained at a macro level, where crime rates are linked to economic structures and performance ([Fajnzylber et al., 2002](#)). According to the classical economic theory of crime, *ceteris paribus*, economic expansion, which leads to higher income and employment, would reduce crime levels as the benefits from legitimate sources would surpass those from illegitimate means.

[Danziger and Wheeler \(1975\)](#), drawing on [Merton's \(1938\)](#) social structure explanation of crime, theoretically demonstrated and empirically confirmed that an increase in aggregate income results in more crime when income distribution remains constant or income inequality is high. In this framework, an individual's utility or satisfaction depends on their reference group, the average income of this group, their own income, and their taste for equality. Consequently, during periods of overall economic expansion, individuals who suffer from structural inequality and face frustrated attempts to increase their income or well-being (through education, longer working hours, etc.) to match their reference group may abandon legitimate means and resort to illegal activities. [Danziger and Wheeler \(1975\)](#) illustrated this with the example of racial discrimination against the black population and the crime levels within this group in the United States. While they acknowledged the possibility of ambiguous effects of macro-level income on crime in contexts of income inequality, they did not explicitly present the hypothesis of non-linearity.

The theoretical associations suggested by [Becker \(1968\)](#) and [Danziger and Wheeler \(1975\)](#) regarding the effect of economic expansion on crime are connected by [Hemley and McPheters \(1975\)](#), who proposed two opposing hypotheses to explain this relationship: the "environmentalist" and "technocratic" hypotheses. According to [Hemley and McPheters \(1975\)](#), the environmentalist hypothesis suggests that "economic growth disrupts the stability of the human environment and contributes to crime and other anti-social actions." In contrast, the technocratic hypothesis posits that "increased production, output, and income actually act to prevent crime, mainly because the production process provides income and employment to persons who might otherwise turn to crime." [Hemley and McPheters \(1975\)](#) described this association between economic performance and crime as a U-shaped relationship, wherein an initial increase in aggregate income reduces crime to a point, after which the relationship inverts.

In sum, the theoretical foundation of this study is built on the contributions of [Becker \(1968\)](#), [Danziger and Wheeler \(1975\)](#), and [Hemley and McPheters \(1975\)](#). The U-shaped association between macro-level income and crime is inspired by [Hemley and McPheters \(1975\)](#). The inverse association, where increased income reduces crime, is rooted in the economic theory proposed by [Becker \(1968\)](#). Conversely, the possibility of a positive association, where increased income leads to more crime under certain conditions, is based on the social structure theory from [Danziger and Wheeler \(1975\)](#).

Regarding crime deterrence or prevention at the macro level, the economic approach ([Becker, 1968](#)) advocates measures that increase punishments and the costs associated with committing crimes, making the benefits of crime less attractive. In practice, this implies government expenditure on public safety, such as policing and the justice system. Conversely, the social structure approach ([Danziger & Wheeler, 1975](#)) advocates measures that mitigate the effects of social flaws on individuals, such as reducing inequality and deprivation.

The theoretical link between crime and economic conditions detailed thus far has been empirically tested in the literature. Most empirical studies investigating the relationship between economic growth and crime focus on the impact of crime on growth. However, conversely, alongside a few studies, this study asserts that the economic condition of a nation plays an important role as a determinant of its crime rates.

[Table A2](#) (in the annex) provides details concerning the objectives, data, methodology, and conclusions of various empirical studies that have investigated the relationship between economic growth and crime. A general overview of [Table A2](#) shows a preeminence of studies

interested in the effect of crime on economic growth (Detotto & Otranto, 2010; Enamorado, López-Calva, & Rodríguez-Castelán, 2014; Goulas & Zervoyianni, 2013, 2015; Neanidis & Papadopoulos, 2013; Torres-Preciado, Polanco-Gaytán, & Tinoco-Zermenó, 2015; Yearwood & Koinis, 2011) compared to those that study the opposite direction of effect (Fajnzylber *et al.*, 2002; Hemley & McPheters, 1975). The existence of empirical studies regarding both directions of effect indicates endogeneity between economic performance and crime. Nonetheless, the focus here is on the effect of economic conditions on crime rates and not the other way around.

The effect of economic conditions on individuals' decisions concerning crime is not a recent topic. Hemley and McPheters (1975) examined the external diseconomies, such as crime, that economic growth may provoke, proposing two opposing hypotheses that align with the non-linearity to be tested in this study. The first hypothesis suggests that economic growth disrupts the stability of the human environment, leading to an increase in crime rates. The second hypothesis posits that increased production, output, and income may prevent crime because individuals are employed and earn income. The results found by Hemley and McPheters (1975) confirmed the first hypothesis, indicating that economic growth, characterized by higher production and income levels, contributes to increasing crime. Conversely, Fajnzylber *et al.* (2002) concluded that economic expansion, measured by higher GDP growth, reduces crime rates of intentional homicide and robbery.

Detotto and Otranto (2012) acknowledged that the link between economic growth and crime is quite puzzling and, therefore, avoided seeking a causal relationship, focusing instead on the co-movements between both variables. Their results affirmed a strong relationship between business cycles and various types of crime, concluding that a rise in economic performance is associated with a decrease in crime rates. Furthermore, Detotto and Otranto (2012) identified the lagging behavior of crime series, suggesting the use of dynamic models.

Despite the differences regarding the direction of effect investigated, Table A2 (in the annex) indicates a consensus on data type and methodology. The frequent use of panel data of regions or countries to estimate General Method of Moment models (GMMs) is notable. This is particularly because these models allow for controlling regional heterogeneity and time dynamics across locations and also address endogeneity, which is suspected to exist between economic growth and crime rates.

Apart from economic performance, factors related to social welfare are also crucial for understanding crime rates (Danziger & Wheeler, 1975). Some studies have shown that absolute deprivation, such as poverty and unemployment, significantly determines crime rates (Messner & Tardiff, 1986; Barata, de Almeida, da Silva, & de Moraes, 1998; Lee, Marotta, Blay-Tofey, Wang, & de Bourmont, 2014; Ceccato, 2017). While acknowledging the role of absolute deprivation, other studies argue that relative deprivation, such as income inequality, plays a more critical role in explaining crime rates (Canache, 1996; Burraston, McCutcheon, & Watts, 2018).

The demographics and social welfare of youths, especially young men, have frequently been identified in the literature as predictors of lethal violence (Shaw & McKay, 1942; Justus, de Castro Cerqueira, Kahn, & Moreira, 2018). Nardi, Arimatea, Giunto, Lucarelli, Nocella, and Bellantuono (2013) found that adolescents and youths who are not engaged in education or training (NEET) are more involved in property crimes and less in crimes against persons. The consumption of psychoactive substances, such as drugs and alcohol, has also been linked to criminal behavior (Valdez, Kaplan, & Curtis, 2007). Additionally, the role of law enforcement has been highlighted in both theoretical and empirical literature as crucial in combating crime (Becker, 1968). Economic studies on crime have shown that government expenditure on policing, prisons, courts, and overall public safety infrastructure contributes to crime deterrence, enhances the overall feeling of safety, and ensures efficient policing and judicial processes (Brand & Price, 2000; Mayhew, 2003).

3. Method

3.1 Data and sample

This study uses panel data from 36 OECD member countries covering the years 2000 to 2018, resulting in a total of 19 years of data. In a balanced panel structure, this would yield 684 observations (36 countries multiplied by 19 years). However, the panel data is unbalanced due to missing data for some countries in certain years.

3.2 Empirical modeling

The empirical method used to achieve the objectives of this paper is that of dynamic panel data models fitted by the General Method of Moments estimators (GMM). Aside from being most adequate for cross-national analyses, this method enables to explore the variations over time and among countries, thus providing more precise estimates. Besides, these models account for the unobserved country-specific fixed effect, time dynamics, and endogeneity of variables, which are potential limitations that cross-sectional or time-series analyses encounter. The general dynamic panel model of order p for homicide rates is represented as

$$\begin{aligned} homicide = \gamma_1 homicide_{i,t-1} + \dots + \gamma_p homicide_{i,t-p} + x^t \beta + \alpha_i + \varepsilon, \\ t = p + 1, \dots, T \end{aligned} \tag{1}$$

where *homicide* is the homicide rate for 100.000 population of country i at time t , α_i represents the country-specific effect, x is a matrix of regressors which are initially assumed to be uncorrelated with the error term, ε . According to [Cameron and Trivedi \(2010\)](#), the main reasons for the correlation of *homicide* over time are: (1) true state dependence, which refers to the direct natural relation of y in preceding periods; (2) observed heterogeneity through direct relation with x and; (3) unobserved heterogeneity through time-invariant country-specific effects, α_i , which in our case may be political institutions or regimes, constitutional laws, ethnic structures, etc. Aside from providing consistent estimates for $\gamma_1, \dots, \gamma_p$ and β , the Arellano-Bond estimator deals with endogeneity by including internal instruments derived from lagged values of the endogenous regressors.

In the equation, the set of regressors, x , are:

- (1) *GDP*: is the control for Gross Domestic Product (in constant values of the year 2015), which is the regressor of major interest of this study. The values used are in constant or real prices, i.e. inflation has been deducted. To test the non-linear hypothesis, the square of GDP is also included in the model. Natural logarithm was applied to both the level and square values of the GDP to reduce the expressive variation of the GDP across the OECD member countries;
- (2) *NEET*: is the control for youths between age 15 and 29 who are neither in employment, education nor training. This control is measured in the proportion of the total population;
- (3) *GINI*: is the GINI index that controls for income inequality;
- (4) *pubsafety*: is the control for government expenditure on public safety. This control is measured in the proportion of the total annual government expenditure;
- (5) *alcohol*: is the control for the consumption of psychoactive substances. This control is measured in liters per capita of alcohol consumed by individuals above age 15;
- (6) *Binaryforyears* and *trend*: are both time controls for year-specific shocks (in binaries) and the linear trend of crime.

- (7) *Binaryforcontinents*: a categorical variable is included as a control for the four continents in which the OECD member countries are contained, namely, North America, Europe, Asia, and Australia.

The hypothesis of an interaction between GDP and income inequality (GINI) is tested by including the product of both variables as a regressor in the model. The statistical significance of this new variable indicates that both variables interact such that the slope of the effect of one changes as the value of the other increases, and vice versa. Note that the individual effect of GDP and GINI should not be interpreted independently after the inclusion of the interaction term since these values are only valid if one of both is equal to zero, which is not realistic in this case. In a model with an interaction term, the individual effect of any of the interacted variable is obtained by combining the individual effect of the variable of interest with the interactive effect.

In the empirical model, the regressors x can be exogenous, weakly endogenous, or contemporary endogenous. Specifically, this study assumes, based on the theoretical model of [Becker \(1968\)](#), that the variable for government expenditure on public safety is potentially endogenous. The reason for this is that crime decisions depend on the conceived probability of apprehension, conviction, and effective punishment by offenders, which are directly influenced by the government through investment in public safety. Moreover, as detailed in the literature review, economic growth is likely endogenous since studies found evidence that crime rates affect growth and vice versa. These variables suspected to be endogenous will be addressed in the GMM method by using internal instruments – lagged values of the variables in level. Therefore, this method deals with endogeneity by controlling it rather than solving it although still providing consistent estimates. Nonetheless, [Arellano and Bover \(1995\)](#) showed that this procedure controls for endogeneity efficiently.

To obtain a consistent estimation of the empirical model, the Arellano-Bond estimator assumes that ε must be serially uncorrelated. Specifically, the first-differenced errors, $\Delta\varepsilon$, are correlated in the AR (1) but not in subsequent orders. The statistics test that verifies this assumption is the Arellano-Bond test. The null hypothesis of this test is that there is no autocorrelation in the first-differenced errors. The test used to verify if the dynamic panel model is misspecified is the Sargan test of overidentifying restrictions. It is important to note that this test assumes that model errors are independent and identically distributed (i.i.d), thus the Sargan test cannot be performed on the heteroskedastic-robust errors.

In posterior publications [Arellano and Bover \(1995\)](#) and [Blundell and Bond \(1998\)](#) suggested to consider an additional moment condition, $E(\Delta homicide_{1,t-1}, \varepsilon) = 0$, in order to enable the inclusion of levels as in [Equation \(1\)](#) and use $\Delta y_{1,t-1}$ as an additional internal instrument to address endogeneity. This latter version of the GMM estimator called the System Dynamic Panel-Data Estimator (abbreviated, GMM-SYS) satisfies the moment conditions stipulated in previous paragraphs. The GMM-SYS presents more consistent estimates in the sense that it controls for individual fixed effects, α_i , intertemporal dynamics of dependent and independent variables, endogeneity, and heteroskedasticity can be accounted for by using robust standard errors. For this reason, the GMM-SYS is used for the analysis of this study.

3.3 Preliminary econometric procedures

[Table 1](#) presents the preliminary statistics for the dependent and independent variables specified in the empirical model.

Although the OECD member countries share similar development goals and policies, they are heterogeneous in terms of institutional, judicial, and social structures. This is reflected by the standard deviations (s.d.), whereby the overall deviation shows the average variability of the data; the between deviations show how the data vary across countries, and; the within

Variable	Definition		Mean	s.d	<i>N</i> , <i>i</i> , <i>T</i>
<i>homicide</i>	Intentional Homicide Rate (homicides for 100 000 population)	Overall	2.33	3.15	<i>N</i> = 586
		Between		2.76	<i>i</i> = 35
		Within		1.37	$\bar{T}$ = 16.7
<i>GDP</i>	Gross Domestic Product (in million US\$, constant prices of the year 2015)	Overall	1,197,265	2,729,203	<i>N</i> = 684
		Between		2,747,202	<i>i</i> = 36
		Within		290,928	<i>T</i> = 19
<i>NEET</i>	The proportion of young people between age 15 and 29 who are neither in employment, education nor training (%)	Overall	14.85	6.51	<i>N</i> = 592
		Between		5.91	<i>i</i> = 35
		Within		2.71	$\bar{T}$ = 16.9
<i>GINI</i>	Gini (disposable income, post taxes and transfers)	Overall	0.31	0.05	<i>N</i> = 291
		Between		0.06	<i>i</i> = 34
		Within		0.01	$\bar{T}$ = 8.6
<i>pubsafety</i>	Public safety investment (% of GDP)	Overall	3.97	1.24	<i>N</i> = 564
		Between		1.34	<i>i</i> = 32
		Within		0.38	$\bar{T}$ = 17.6
<i>alcohol</i>	Alcohol consumption – liters per capita (age 15+)	Overall	9.41	2.84	<i>N</i> = 636
		Between		2.74	<i>i</i> = 36
		Within		0.84	$\bar{T}$ = 17.7

Table 1.
Definition and
descriptive statistics

Note(s): S.d. is the standard deviation; *N* is the number of observations; *i* represents units (countries), and; *T* is time (number of years) and $\bar{T}$ is the average of *T* in cases where data is unavailable for specific years
Source(s): Table by authors'

deviations show how data vary over time. A higher between deviation for most of the variables emphasizes the differences among OECD member countries, emphasizing the necessity of a method such as the GMM-SYS that addresses country-specific effects, i.e. heterogeneity.

The modeling exercise begins with the estimation of the base model using various panel data methods, whereby all the regressors are included. Before estimating models using the GMM method, the classic pooled linear, Random, and Fixed Effect models (abbreviated as OLS, RE, and FE, respectively) are estimated to ensure that the GMM is the most appropriate method.

The results and test values obtained are in Table 2. The heteroskedasticity, collinearity, and residual normality are tested using the linear model estimated by the OLS method. The test values indicate that the residuals of the base model are normally distributed at a 5% level of significance but not at 1%. Notwithstanding, the comparison of the residual distribution to the conceptual normal distribution shows that the distribution of the calculated residuals is close to normal. Therefore, normality is assumed. The Breush-Pagan test for heteroskedasticity indicates that the residuals do not have constant variance. Given the size of the database (*N* = 205) and the number of regressors that are controlled (total of 23, including time and continental binaries), robust standard errors are not calculated. Nevertheless, the distribution of the residuals is decently distributed around the zero average. Therefore, we assume homoskedasticity. The empirical models with robust standard errors are provided in Table A1 (in the annex section) for consultation.

The F, Breush-Pagan, and Hausman tests used to identify the best fit model between the classic linear, RE, and FE models show that the FE model is most appropriate. The flaw of these three models is that they are biased in the presence of serial correlation of the dependent variable or the presence of an endogenous regressor in the model, which is likely to be the case of the control for public safety expenditure, *pubsafety*. These issues are addressed by the GMM estimators, which builds on the FE models.

	OLS	RE	FE	GMM-SYS
$\log(GDP)$	-7.157*** (0.601)	-4.522*** (1.509)	-3.754 (3.483)	-3.134** (1.540)
$\log(GDP)^2$	0.277*** (0.023)	0.172*** (0.059)	0.0621 (0.137)	0.118* (0.063)
$NEET$	0.0295 (0.018)	0.0278 (0.018)	0.00256 (0.022)	0.0359** (0.018)
$GINI$	2.562 (2.341)	-2.844 (3.097)	-4.162 (3.341)	3.038 (3.762)
$pubsafety$	28.42*** (7.271)	72.01*** (9.966)	73.00*** (11.107)	53.83*** (11.087)
$alcohol$	0.110*** (0.034)	0.146*** (0.049)	0.148*** (0.054)	0.206*** (0.063)
$homicide_{t-1}$				0.418*** (0.056)
$constant$	44.13*** (4.120)	27.39*** (9.846)	36.56 (22.401)	15.87 (9.757)
N	217	217	217	205
R^2	0.621		0.361	
<i>Statistic tests</i>				
Test	Value			
Heteroskedasticity: Breush-Pagan	$\chi^2 = 21.09$; p -value 0.000			
Collinearity: Variance Inflation factor	mean VIF 1.41			
Normality: Shapiro-Wilk	w 0.9837; p -value 0.0132			
Pooled vs FE: F -test	F 36.69; p -value 0.000			
Pooled vs RE: Breusch and Pagan test	$\bar{\chi}^2$ 489.48; p -value 0.000			
FE vs RE: Hausmann test	$\chi^2 = 31.73$; p -value 0.000			
Autocorrelation: Arellano-bond				
Order 1	$z = -2.83$; p -value 0.0066			
Order 2	$z = -1.41$; p -value 0.1626			
Over-Identification: Sargan (one-step)	$\chi^2 = 139.04$; p -value 0.001			
Over-Identification: Sargan (two-step)	$\chi^2 = 13.99$; p -value 1.000			
Note(s): ***, **, and * denote significance at 1, 5, and 10%, respectively; OLS is the classic linear regression, FE is the Fixed Effect model; RE is the Random Effect model; GMM-SYS is the System Generalized of Moments Method				
Source(s): Table by authors'				

Table 2.
Estimation procedures
and statistic tests

The Arellano-Bond test for serial correlation rejects the null hypothesis of zero correlation in the first-differenced errors only at order 1. Therefore, the moment conditions used by GMM estimator are satisfied and the GMM method can be used for analysis. The Sargan test is performed on the GMM-SYS I (the base model) to verify the model specification and the validity of instruments. The test value for a one-step GMM-SYS model rejects the null hypothesis that the overidentifying restrictions are valid, i.e. the model and instruments need to be reviewed. It is, however, important to recall that the Sargan test overrejects in the presence of heteroskedasticity, which seems to be the case as indicated in the linear model estimated using the OLS method. For further assessment, the same GMM-SYS model is estimated using a two-step procedure as suggested by [Arellano and Bond \(1991\)](#). The Sargan test result for the two-step model does not reject the null hypothesis that the overidentifying restrictions are valid.

The statistical procedures performed here indicates that the GMM-SYS yields better estimates compared to other panel data models assessed. Therefore, this model is henceforth referred to as the base model, and all the empirical analysis of this study is focused exclusively on models estimated using this method.

Three specification exercises were performed building on the base model estimated using the GMM-SYS method and presented in Table 3 that is analyzed in the next section. In the first variation, GMM-SYS I, the endogeneity of the GDP and governmental expenditure on public safety is controlled using internal instruments as described in the methodology section. In the model GMM-SYS II, controls are included for continental and time-specific effects, and the interaction between GDP and income inequality (GINI) is tested in model

	GMM-SYS I	GMM-SYS II	GMM-SYS III
<i>Intercept</i>	16.11*** (3.117)	18.13*** (3.314)	9.928*** (3.179)
<i>Homicide_{t-1}</i>	0.532*** (0.036)	0.532*** (0.036)	0.459*** (0.038)
<i>Interest variables</i>			
<i>log(GDP)</i>	-2.830*** (0.461)	-3.187*** (0.505)	-3.163*** (0.468)
<i>log (GDP)²</i>	0.109*** -2.830***	0.125*** -3.187***	0.189*** -3.163***
<i>GINI</i>	4.982*** (1.494)	5.268*** (1.453)	66.34*** (9.498)
<i>GINI × log(GDP)</i>			-5.390*** (0.810)
<i>Control variables</i>			
<i>alcohol</i>	0.0764*** (0.026)	0.0896*** (0.032)	0.0421 (0.030)
<i>NEET</i>	-0.0118 (0.011)	-0.0139 (0.011)	-0.00734 (0.011)
<i>pubsafety</i>	38.71*** (8.159)	43.27*** (8.202)	43.65*** (7.877)
<i>pubsafety_{t-1}</i>	-21.51** (8.442)	-22.56*** (8.529)	-23.95*** (8.192)
Continent-fixed effects	No	Yes	Yes
Time-fixed effects	No	Yes	Yes
<i>Tests</i>			
Autocorrelation test: Arellano-bond: <i>z</i> (<i>p</i> -value)			
order 1	-2.3 (0.023)	-2.2 (0.030)	-2.5 (0.012)
order 2	-1.6 (0.11)	-1.6 (0.11)	-1.35 (0.18)
Over-Identification test: Sargan χ^2 (<i>p</i> -value)			
one-step	213.5 (0.098)	176.5 (0.45)	180.01 (0.36)
two-step	19.9 (1.00)	3.4 (1.00)	3.4 (1.00)
Normality test: Shapiro-wilk <i>w</i> (<i>p</i> -value)	0.98 (0.082)	0.98 (0.098)	0.98 (0.082)

Note(s): GMM-SYS I is the base model with control for the endogeneity of GDP and governmental expenditure on public safety and its lagged effect, and control for binaries for continents; GMM-SYS II includes time shock controls to model GMM-SYS I; GMM-SYS III adds the control for the interaction between GDP and GINI; the number of observations for the four models is 205; ***, ** and * denote significance at 1, 5, and 10%, respectively

Source(s): Table by authors'

Table 3.
The empirical
specifications and
result for
homicide rates

GMM-SYS III. Note that changes in the model specifications did not severely affect the results, i.e. the estimates are relatively stable across models, especially for the main variables of interest, i.e. GDP and GINI. The magnitude of the GDP and *GINI* coefficients vary significantly in GMM-SYS III compared to other models due to the effect of the interaction on the average values.

4. Results and discussion

Classic economic theories of crime (Becker, 1968) primarily focus on the effect of economic conditions on crime. However, criminological and recent economic theories have emphasized the need to look beyond economics to explain crime, particularly in relation to crimes against persons, such as aggression and lethal violence (Merton, 1938; Danziger & Wheeler, 1975; Fajnzylber *et al.*, 2002). In this broader framework, social structures, including factors like income distribution and crime culture, are also crucial in explaining crime. This study integrates insights from both economic and criminological frameworks to expand the literature on the determinants of homicide rates (a proxy for lethal violence).

The relationship between economic conditions and crime is more complex than it initially appears (Pridemore, 2011), as higher income levels may reflect improved living conditions where crime becomes less necessary or attractive. On one hand, theoretical and empirical studies suggest that overall income growth reduces crime (Danziger & Wheeler, 1975). On the other hand, other studies indicate the opposite (Becker, 1968; Hemley & McPheters, 1975). In line with Hemley and McPheters (1975), this study acknowledges this complexity and hypothesizes that the relationship between absolute income (GDP) and crime (homicide rates, in this case) is non-linear—initially negative and then positive (U-shaped). This hypothesis is confirmed across all estimation exercises performed in this study, indicating that GDP has a significant and non-linear effect on homicide rates. Specifically, the effect of GDP on homicide rates (a proxy for lethal violence) in OECD member countries is inverse at lower GDP levels and positive at higher GDP levels. Thus, *ceteris paribus*, economic expansion tends to be particularly influential in reducing homicide rates in countries with lower GDP, while the opposite holds true for those with higher GDP. It is also noteworthy that, on average, the mitigating effect of GDP on homicide rates is dominant.

The graphical illustration of the non-linear relationship between GDP and homicide rates (Figure 1) depicts a U-shaped curve, with the lowest point of the parabola identifying the transition between the two segments of the curve—one with a negative sign and the other with a positive sign. Countries falling below the lowest point, characterized by a negative sign, include Iceland, Estonia, Latvia, Lithuania, Slovenia, Luxembourg, Slovak Republic, Hungary, New Zealand, Czech Republic, Chile, Portugal, Ireland, Greece, Finland, and Israel. Conversely, countries above the lowest point, characterized by a positive sign, include Denmark, Norway, Austria, Poland, Belgium, Sweden, Switzerland, Turkey, Netherlands, Mexico, Canada, Italy, France, United Kingdom, Germany, Japan, and the United States.

In Figure 1, it is evident that Estonia and Latvia, neighboring countries in Northern Europe, are positioned at the lowest extreme of the curve, where GDP is the lowest and crime rates are the highest. Conversely, the United States is at the highest extreme of the curve, where both GDP and crime rates are the highest. Mexico, which is not included in the figure due to being an outlier, had the highest homicide rates during the period (an average of 15.8) combined with an average GDP level (about 13.8). This highlights that the effect of economic growth on crime levels depends on the existing economic conditions of a country: GDP growth tends to reduce homicide rates in the context of low pre-existing income but may increase homicide rates when the country already has high pre-existing income.

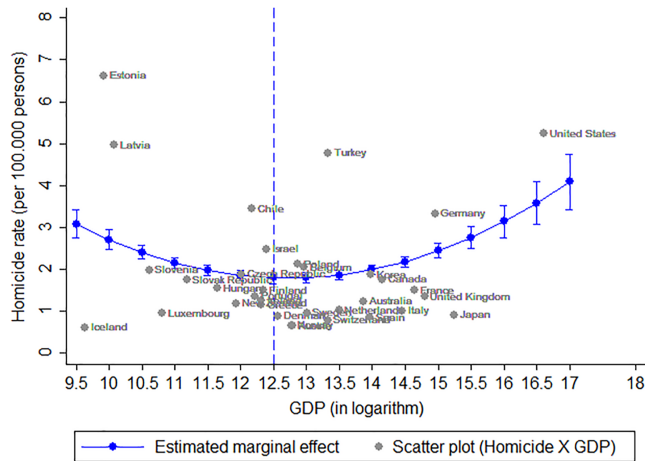


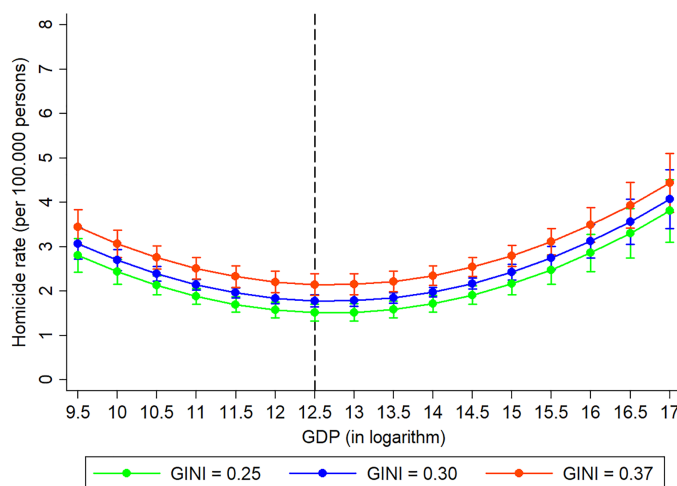
Figure 1.
The non-linear
marginal effect of
gross domestic product
(GDP) on
homicide rates

Note(s): The broken vertical line indicates the lowest point of the U curve and the bars around the marginal effects are confidence intervals. All the marginal effects plotted are statistically significant at 1%. Mexico is excluded in the figure to avoid the distortion of the data illustration due to the exceptionally high rates of lethal crimes. The scatter plot is calculated using the average values between the year 2000 and 2018

Source(s): Figure created by the authors using results from model GMM-SYS II

It is important to recognize that increasing absolute income alone is insufficient to gauge the economic welfare of a country's population, as this largely depends on how income is distributed. The coefficient for GINI, which measures income inequality, is positive and significant across all models, indicating that higher levels of income inequality lead to increased homicide rates. The magnitude of this coefficient suggests that income inequality is the second most influential factor on homicide rates, with its effect being about twice as strong as the mitigating effect of GDP growth. In other words, *ceteris paribus*, a simultaneous increase in both GDP and GINI would result in higher crime levels. Without considering the interactive effect between GDP and GINI (as seen in models GMM-SYS I or GMM-SYS II), Figure 2 illustrates that higher GINI levels increase homicide rates regardless of GDP levels, causing parallel shifts in the curves. Additionally, the effect of GINI on homicide rates is portrayed as linear and constant in models GMM-SYS I and II (indicated by the consistent gaps between the GINI lines), meaning the impact of inequality on crime remains the same across all levels of GDP.

According to Fajnzylber *et al.* (2002), economic growth and income inequality are the most robust and significant determinants of crime. Although Fajnzylber did not provide an explicit empirical test, he describes the effect of poverty alleviation on crime rates as being influenced by the joint effect of income inequality and economic growth. This joint effect hypothesis has been long proposed by Danziger and Wheeler (1975), who theoretically and empirically demonstrated that “a greater degree of inequality in the distribution of income and increases in the absolute level of income when the distribution is constant are both accompanied by more crime.” In other words, the magnitude of the effect of income growth on crime is conditioned by the level of income inequality. Therefore, GDP and GINI are expected to interact naturally, with GDP reflecting the absolute level of income and GINI indicating its distribution among the population.



Note(s): The broken vertical line indicates the lowest point of the U curve and the bars around the marginal effects are confidence intervals

Source(s): Figure created by the authors using results from model GMM-SYS II

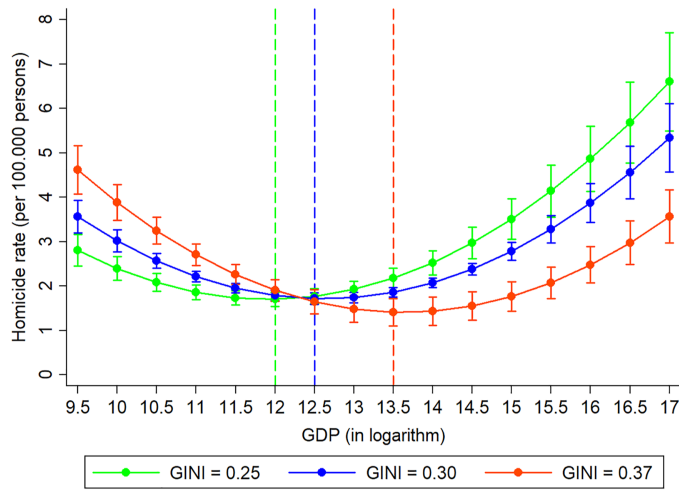
Figure 2.
Non-linear marginal effect of gross domestic product (GDP) on homicide rates across different levels of income inequality (GINI)

Specifically, the interaction effect between GDP and GINI hypothesized in this study suggests that the impact of GDP on homicide rates varies depending on different levels of income inequality. This hypothesis is confirmed by the significant negative sign observed for the interaction term in model GMM-SYS III. This result implies that the overall effect of GDP on homicide rates is influenced by the level of income inequality. Notably, the interaction effect affects the slope of the curve, indicating that the marginal effects of GDP on homicide rates are directly influenced by the level of inequality.

Apart from the dependence between GDP and GINI, the negative sign of the interaction term indicates that the inverse or mitigating effect of GDP is emphasized at higher levels of income inequality and the positive or direct effect is reduced at high levels of income inequality. In other words, the role of GDP in reducing homicide rates is greater in contexts of higher income inequality compared to context with lower income inequality. The illustration of these interaction effects in Figure 3 prompts three observations. First, the slope of the curves shows that the marginal reduction caused by GDP growth is higher in the context of higher inequality. Second, the shift of the lowest point of the curves to the right as income inequality increases shows that higher values of GDP go a long way in reducing homicide rates in the context of higher inequality compared to that of lower inequality. Third, the positive effect of GDP growth on homicide rate is lower compared in the context of higher inequality compared to that of lower inequality. In sum, the interaction exercise illustrated in Figure 3 shows that GDP growth is most efficient in reducing crime in the context of high inequality. This is mostly because there is room for more improvements in such contexts.

The control for *pubsafety* shows that the government expenditure on public safety in a period reduces homicide rates in the subsequent period. There is consensus in the literature that the role of government investment in public safety factors such as, for example, policing, prisons, and courts is crucial in tackling crime (Becker, 1968; Fajnzylber *et al.*, 2002). These factors are directly associated with crime deterrence, which is crucial in reducing crime rates (Danziger & Wheeler, 1975). The evidence presented here upholds this by showing that

Figure 3.
Interaction effect
between gross
domestic product
(GDP) and income
inequality levels (GINI)
on homicide rates



Note(s): The broken vertical line indicates the lowest point of the U curve
Source(s): Figure created by the authors using results from model GMM-SYS II

government expenditure on law enforcement reduces homicide rates, although with a year of lag. Despite acknowledging the importance of law enforcement, [Danziger and Wheeler \(1975\)](#) suggest that crime reduction could be further achieved in the long run by the reduction of inequality rather than increasing punishment or adjusting other law enforcement factors. This is because the former approach influences a cause of crime and is beneficial to the population at large, whereas the latter approach mostly only affects the offender's probability of getting caught or crime deterrence and is costly to the society at large.

The control for the consumption of psychoactive substances, *alcohol*, indicates that higher consumption of alcohol increases the homicide rates, but this result is only confirmed in two of the three models estimated in this study. Nonetheless, the result presented here upholds that of [Rossow \(2001\)](#) regarding Europe; that of [Shaw et al. \(2006\)](#) regarding England and Wales, and; that by [Valdez et al. \(2007\)](#) for the United States.

There is not enough evidence to decide regarding the effect of the proportion of disconnected youths, NEET, on homicide rates. This result aligns with that reported by [Nardi et al. \(2013\)](#) that deviant and criminal behaviors, especially homicides, are not linked to youths who are NEET.

The three variations of the GMM-SYS model present evidence of the inertia of homicide rates over time, i.e. the homicide rate of a specific period is affected by that from the preceding period.

5. Conclusions

This study tests two hypotheses: first, that homicide rates decrease as GDP increases (the economic hypothesis), although the opposite effect may occur as GDP increases in contexts of high income inequality (the social structure hypothesis). Second, it examines whether there is an interaction effect between GDP and income inequality on homicide rates, where the impact of GDP on homicide rates is conditioned by and varies across different levels of income inequality.

Regarding the first hypothesis, the relationship between GDP and homicide rates (a proxy for lethal violence) is found to be non-linear. This implies that the impact of economic

expansion on lethal crimes depends on the pre-existing economic conditions. Specifically, an increase in GDP reduces homicide rates when the initial GDP is low, but the opposite effect is observed in contexts with high pre-existing GDP.

The group of OECD member countries where an inverse association is found between homicide rates and GDP are namely, Iceland, Estonia, Latvia, Lithuania, Slovenia, Luxembourg, Slovak Republic, Hungary, New Zealand, Czech Republic, Chile, Portugal, Ireland, Greece, Finland, and Israel. And the group of country where a direct association is found are Denmark, Norway, Austria, Poland, Belgium, Sweden, Switzerland, Turkey, Netherlands, Mexico, Canada, Italy, France, United Kingdom, Germany, Japan, and the United States. In other words, economic growth results in the reduction of lethal violence in the first group but results in the opposite in the second group.

Regarding the second hypothesis, it is found that the increase in homicide rates resulting from a unit increase in income inequality is approximately twice as significant as the reduction caused by a unit increase in GDP. Furthermore, income inequality not only increases homicide rates but also influences the effect of GDP on these rates. Specifically, GDP growth is most effective at reducing crime in contexts of high income inequality, as there is greater potential for improvement. Therefore, public safety in countries with high inequality benefits more from economic growth compared to those with low inequality. These results suggest that policies and social programs aimed at reducing income inequality can substantially decrease lethal crimes, particularly in contexts with high levels of inequality.

The results indicate that government expenditure on policing, courts, prisons, and the justice system effectively reduces homicide rates in subsequent periods. A balanced approach, combining investments in law enforcement with inequality reduction programs or policies, seems to be a promising strategy for reducing homicide rates. This dual approach addresses crime both in the short term through enhanced law enforcement and in the long term by addressing the underlying social flaws that contribute to crime.

Many European countries have adopted stricter policies towards the sales of alcoholic beverages and the use of other psychoactive substances in order to reduce crimes. Nonetheless, this continues to be a determinant factor of homicide rates. The studies reviewed here suggest that more efforts could be made in this direction focusing on specific seasons of the year and regions.

Given the dual effect of GDP on homicide studies pointed out in this study, it is suggested that future studies consider estimating a separate models for the two group of countries identified in this studies based on the sign of the effect of GDP on homicide rate to better understand the mechanisms behind the rates of lethal crimes. Moreover, the non-linear effect of income inequality on homicide rates signalized in the empirical analysis is beyond the scope of this study and should be further investigated.

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(The Appendix follows overleaf)

Appendix

	GMM-SYS I	GMM-SYS II	GMM-SYS III
<i>Intercept</i>	16.11** (7.856)	18.13** (9.192)	9.928 (6.915)
<i>Homicide_{t-1}</i>	0.532*** (0.151)	0.532*** (0.148)	0.459*** (0.133)
<i>Interest variables</i>			
<i>log(GDP)</i>	-2.830** (1.285)	-3.187** (1.526)	-3.163*** (1.209)
<i>log (GDP)²</i>	0.109** -2.830***	0.125** -3.187**	0.189*** -3.163***
<i>GINI</i>	4.982 (4.228)	5.268* (3.263)	66.34*** (20.520)
<i>GINI × log(GDP)</i>			-5.390*** (1.730)
<i>Control variables</i>			
<i>alcohol</i>	0.0764 (0.062)	0.0896 (0.077)	0.0421 (0.064)
<i>NEET</i>	-0.0118 (0.015)	-0.0139 (0.016)	-0.00734 (0.014)
<i>pubsafety</i>	38.71* (23.363)	43.27** (21.695)	43.65** (22.226)
<i>pubsafety_{t-1}</i>	-21.51 (19.349)	-22.56 (18.697)	-23.95 (19.109)
Continent-fixed effects	No	Yes	Yes
Time-fixed effects	No	Yes	Yes

Table A1.
The empirical
specifications and
result for homicide
rates (with robust
standard errors)

Note(s): GMM-SYS I is the base model with control for the endogeneity of GDP and governmental expenditure on public safety and its lagged effect, and control for binaries for continents; GMM-SYS II includes time shock controls to model GMM-SYS I; GMM-SYS III adds the control for the interaction between GDP and GINI; the number of observations for the four models is 205; ***, ** and * denote significance at 1, 5, and 10%, respectively

Source(s): Table by author's

Author	Objective	Data and methodology	Conclusions
Hemley and McPheters (1975)	Examine the empirical relationship between crime rate and various measures of economic production and income	OLS, using 1933–1970 data from the U. S. Department of Justice	Increasing levels of production and income may also generate levels of criminal activity which strain the ability of society to cope with and deter them
Fajnzylber <i>et al.</i> (2002)	Analyze the determinants of national crime rates both across countries and over time	GMM estimators, using 1970–1994 cross-national panel data	There is a negative effect of GNP growth rate on the rates of intentional homicide and robbery
Detotto and Otranto (2010)	Study the impact of crime on economic performance in Italy	Step-wise regression, using 1977–2007 United States data	Crime acts are like a tax on the entire economy: it discourages domestic and foreign direct investments, reduces the competitiveness of firms, and reallocates resources, creating uncertainty, and inefficiency
Yearwood and Koinis (2011)	Analyze the puzzling links between unemployment and crime rates. Specifically about the effect of crime on economic growth	Theoretical modeling and simulations	An increase in the crime rate among the unemployed has a negative influence on the unemployment rate and growth rate. Nonetheless, an increase in the crime rate among employed workers might help to improve unemployment and promote economic growth
Detotto and Otranto (2010)	Detect some comovements between the business cycle and the cyclical component of some typologies of crime, which could evidence some relationships between these variables	Nonparametric version of dynamic factor model, using 1991–2004 monthly data from Italy National Statistical Institute	A rise in economic performance is associated with a decrease in the total crime rate
Goulas and Zervoyianni (2013)	Explore how the crime-uncertainty interaction impacts on economic growth	System-GMM, using panel data of 25 countries over the period 1991–2007	Findings indicate that higher-than-average macroeconomic uncertainty enhances the adverse impact of crime on growth
Neanidis and Papadopoulou (2013)	Study the link between crime and fertility and the way by which they jointly impact on economic growth	GMM-difference, using 1970–2008 Cross-national data	There is a negative effect of crime on output Growth
Enamorado <i>et al.</i> (2014)	Study the effect of drug-related and non- drug-related crimes on income-growth	OLS and 2SLS estimators, using Mexico's cross-municipality data for the years 2005 and 2010	Evidence was only found concerning the negative effect of drug-related crimes on income-growth

(continued)

Table A2.
The literature review
on the association
between economic
growth and crime

Author	Objective	Data and methodology	Conclusions
Goulas and Zervoyianni (2015)	Examine the relationship between crime and per-capita output growth	System-GMM, using panel data of 26 countries for 1995–2009	Crime does not seem to be so harmful to growth when economic conditions are sufficiently satisfactory. But crime negatively affects when there is pessimism, low employment and high government spending on public safety
Torres-Preciado et al. (2015)	Examine the effects of crime on regional economic growth in Mexico	Spatial panel data by states using 1997 and 2011 Mexico's data	Crime exerts a negative total effect on economic growth across Mexican states

Table A2.

Note(s): Table by author's

About the authors

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