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Economic Activity and Crime in the Long Run: An Empirical Investigation on Aggregate Data from Italy, 1951–1994

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The paper analyzes the economic determinants of crime rates in Italy over the period 1951 to 1994. We show that cointegrating relationships connect the long-run equilibrium levels of crime rates to economic factors in the presence of endogenously determined structural breaks. The long-run pattern of homicides and robberies can be better explained by consumption, whereas thefts are better explained by unemployment. © 1998 by Elsevier Science Inc.

I. Introduction

The theoretical and empirical work about the economics of crime has grown considerably since Becker's (1968) seminal paper. Several issues have been investigated, especially in the fields of the participation in crime activities and the efficient design of punishments.[1]

As to the links between crime and economic variables, two empirical approaches have been developed. The first one involves the construction and estimation of "large" models in which several relationships connect economic variables and crime measures. This permits (at least in principle) a detailed explanation of several features of crime activity. However, the consensus on the most important links is not unanimous, and consistent structural models seem to be out of reach so far.

Several researchers have, therefore, developed an alternative, data-oriented approach that favors simple modeling of time-series analysis.[2] The aim of this approach is to determine the most relevant economic influences on crime in an "atheoretical" frame-

We are indebted to two anonymous referees for valuable comments. We would also like to thank L. A. Franzoni, L. Lambertini, and C. Scarpa for useful suggestions. Any remaining errors are ours. All data, along with the regression results not reported in the text, are available upon request.

[1]For a recent review of the literature, see Pyle (1995) or Ehrlich (1996).

[2]Ehrlich (1996) provides a list of references.

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work. The time-series approach finds, therefore, its own justification through the usefulness of the empirical answers it can provide to "naive" questions concerning the links between economic and crime variables.

This paper applies this line of research to the case of Italy over the last forty years (1951–1994); it tries to figure out which economic variable, among consumption, wealth, and unemployment, is more tightly related to crimes in the long run. We consider different types of crime, namely homicide, robbery, and theft, which are different in nature and require different structural models. In particular, economic explanations are not very common for homicide, which is not a crime against property. However, our data-oriented approach overcomes this point.

We analyze the long-run relationships between the economy and crime by using the tools provided by cointegration analysis. The focus on long-run relations is the most innovative point of the present paper, compared to the studies that generally focus on the short-run cyclical behavior of economic activities and crime.

However, the focus on the long run does not necessarily imply a unique and stable long-run relationship. If we did not take into consideration possible breaks in the cointegrating relationships, no long-run links would emerge.[3] On the contrary, such links emerge clearly once the break is taken into account. We use the procedure suggested by Gregory and Hansen (1996) to select the break in the cointegration relationship endogenously. In all cases analyzed in the present paper, a statistically significant break occurs. In such a framework, we provide statistical evidence supporting the hypothesis of the causal links between economic variables and crime rates. Encompassing tests on different model specifications then are used to choose the most appropriate explanatory variable for each type of crime.

Our main conclusion is that the level of real *per capita* consumption is the best single economic explanatory factor for the long-run equilibrium level of homicide and robbery rates, whereas the unemployment rate is more appropriate for theft. As to the sign, the relationship between consumption, on the one hand, and homicide and robbery, on the other hand, was negative (although not very strong) until the mid-1960s, becoming positive afterward; the link between unemployment and theft rate, negative till 1969, became positive later. Causality goes from economic variables to crime rates, in the long run as well as in the short run. However, we find that a unique empirical model for these crimes is not adequate, and we offer different economic explanations for the different patterns of the examined crime activities.

The paper is organized as follows. Section II presents the data and describes some of their features, including the integration properties of the series. Section III develops the cointegration analysis, looking both at the long-run static regressions and at the short-run dynamic specifications. In the same section, we carry out encompassing tests to choose the most appropriate model. Section IV concludes.

II. Data

Sources and Description

We analyze annual data from Italy over the period 1951–1994. In particular, we consider three different crime rates: the homicide, the robbery, and the theft rates. In Italy, during the period under scrutiny, there were no racial, religious, and (except for a few

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[3]These reasons, perhaps, have led researchers to focus on short-run links.

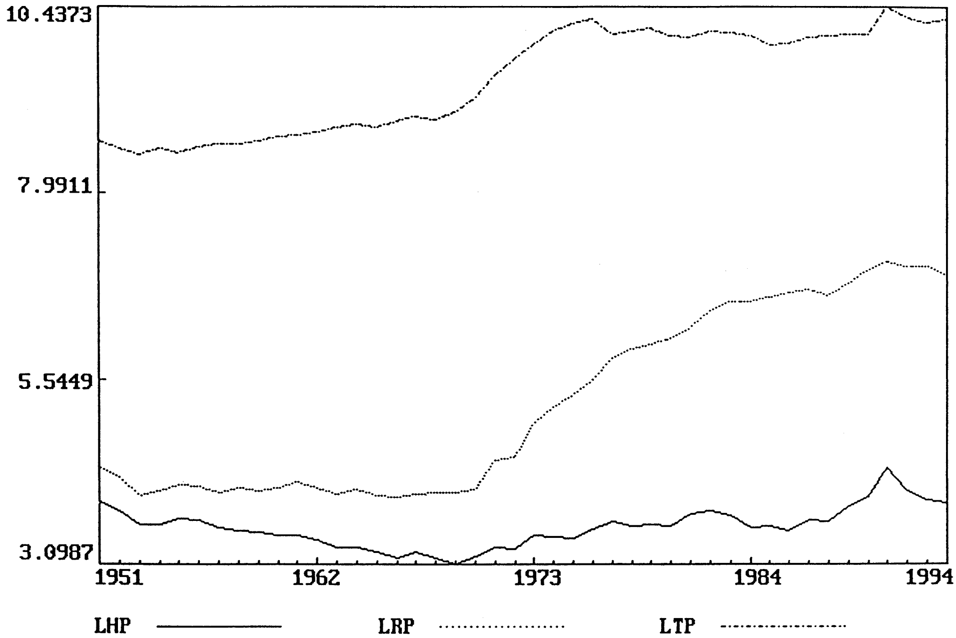

FIG. 1. Crime ratios in Italy, 1951–1994. *LHP* stands for log(homicides/population), *LRP* stands for log(robberies/population), and *LTP* stands for log(thefts/population).

years) political motivations for these crimes. Hence, the economic variables might be the best candidates in the explanation.

ISTAT (1990), the Italian Central Statistical Office, provided all the data used in the paper except for the net financial wealth provided by Rossi and Visco (1995). Homicide figures include the total number of (willful) homicides as well as attempted ones, as reported to the authorities; involuntary homicides are excluded. Robbery figures also include extortion and kidnapping. Theft figures include the reported cases of such crimes against property (including burglary); perhaps the accuracy of the latter series is reduced with respect to the others, because some "petty" thefts are not always reported to the authorities, especially in recent years and in some regions of the country.[4]

All variables are normalized by the total population and then are transformed in the logarithm. The log ratios of crime variables are shown in Figure 1, where *LHP* stands for log(homicides/population), *LRP* stands for log(robberies/population), and *LTP* stands for log(thefts/population).

Italian crime ratios remain relatively stable during the 1950s and 1960s, a period of recovery after World War II and of sustained economic growth. Those years marked an epochal transformation of the country, from agriculture to manufacturing, and witnessed large migration flows from the (southern) countryside to the (northern) industrial cities. The high economic growth rates that characterized the so-called "Italian miracle" of those years died out in the second half of the 1960s. Since 1970 an upward

[4]This suggests a different intensity of crime activities across different regions of Italy. See Marselli and Vannini (1996, 1997) for an empirical analysis.

trend in criminality has emerged. No simple answers can be offered for such a dramatic change. Some authors focus on the social unrest and the political turmoil that characterized the period; others suggest the economic slowdown or the hopeless backwardness of some areas of the country as the main source of the rising trend in crime rates.

The economic series considered are the log-level of the unemployment rate (denoted by *LUR*),[5] the log-level of real per-capita consumption (*LCP*),[6] and the log level of the net private sector, nonhuman wealth in real per capita terms (*LWP*).[7]

Integration Analysis

Widespread agreement exists about the $I(1)$ nature of macroeconomic series.[8] As to the stationarity of the series of crime rates (even standardized), the picture emerging from the literature is mixed. Pyle and Deadman (1994), analyzing British data, find evidence in favor of the $I(2)$ hypothesis, and, therefore, they conclude that crime levels and economic variables cannot be cointegrated. By contrast, they explain the $I(1)$ crime rate growth through macroeconomic variables. If that is correct, however, crime rates would grow indefinitely, even in a stationary economy—a conclusion that seems quite hard to accept. Osborne (1995) analyzes quarterly data from the United Kingdom and, after seasonal adjustments, finds the data to be $I(1)$, but mixed (and partly contradictory) evidence is obtained about the possible cointegration with economic variables. Reilly and Witt (1992) consider Scottish data; even if their sample size (15 annual observations) cannot allow any reliable conclusions about the issue of stationarity, they assume the data to be $I(1)$ and estimate a (short-run) model in first differences.

In this paper, we assume the $I(1)$ nature of all series at hand as a useful hypothesis. Not surprisingly, this hypothesis cannot be rejected at the usual critical values for all series over the period 1951–1994 (see Table 1).

The obvious question to ask is whether some cointegrating relationship between crime rates and economic variables holds. Cointegration means that a stationary linear combination between two or more nonstationary series does exist. The linear combination can be interpreted as the long-run link between the nonstationary series. In the case of two nonstationary time series, X and Y, there is at most one stationary linear combination series $(Y - aX)$. Extensions allow for more than two series and possibly more than one cointegrating relationship. In this paper, we confine ourselves to the case of one cointegration relationship between two series. Y indicates the crime rate (homicide, robbery, or theft) and X indicates the economic explanatory variable (consumption, unemployment, or wealth). Thus, we consider nine pairs of (possibly cointegrating) variables.[9]

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[5]Because of the 1992 change in the labor force definition, we have corrected the last three observations on unemployment rate by simply adding 3% to the official data. This is admittedly a rough adjustment: 3% corresponds to the difference between the values of the unemployment rate in 1992, according to the old and the new criteria, respectively.

[6]The substitution of the gross domestic product series instead of consumption would not affect our conclusions, the correlation between the two series being equal to 0.999. Therefore we report only the results based on the latter variable.

[7]The data on financial wealth cover the period 1951 to 1993.

[8]$I(1)$ means that the series are stationary after one differentiation. However, some recent works cast doubt on the adequacy of this assumption, favoring the hypothesis of stationarity around a broken deterministic trend; see, *inter alia*, Kwiatowski et al. (1992) and Lippi and Reichlin (1994). Indeed, the assumption of the $I(1)$ nature of economic series appears to be a fruitful one in the present framework.

[9]We have analyzed the cases of more than two variables connected by cointegrating relationships in the presence of a structural break, but we did not obtain any additional valuable insight.

TABLE 1. Dickey Fuller tests for unit root (trended case), 1951–1994

Variable	*DF*	ADF_1	*Variable*	*DF*	ADF_1
LHP	−2.51 (−3.52)	−2.38 (−3.52)	ΔLHP	−6.20 (−2.93)	−4.50 (−2.93)
LRP	−2.54 (−3.52)	−2.05 (−3.52)	ΔLRP	−4.36 (−2.93)	−3.33 (−2.93)
LTP	−1.33 (−3.52)	−1.56 (−3.52)	ΔLTP	−5.07 (−2.93)	−3.77 (−2.93)
LUR	−1.27 (−3.52)	−1.69 (−3.52)	ΔLUR	−4.88 (−2.93)	−3.81 (−2.93)
LCP	0.62 (−3.52)	0.09 (−3.52)	ΔLCP	−3.94 (−2.93)	−3.39 (−2.93)
LWP	−2.88 (−3.52)	−2.48 (−3.52)	ΔLWP	−4.26 (−2.93)	−3.25 (−2.93)

Note: Δ denotes the first-difference operator. The null hypothesis is the existence of a unit root. The 5% critical values are in parentheses.

III. Cointegration Analysis

The Long-Run Static Relationship

The most common procedures—namely, the Engle and Granger method, the Johansen method, and the (non) significance of the error-correction term in a procedure *à la* Phillips and Loretan (1991)[10]—do not reject the null hypothesis of no-cointegration for any considered pair of (crime and economic) variables. The results are not reported for the sake of brevity. Thus, we may conclude that no straightforward, stable, long-run relationships exist between the patterns of crime rates and economic variables.

The conclusions are reversed if we allow for the possibility of a regime shift. Gregory and Hansen (1996, p. 100) state that "in some empirical exercises, a researcher may wish to entertain the possibility that the series are cointegrated, in the sense that a linear combination of the nonstationary variables is stationary, but that this linear combination (the cointegrating vector) has shifted at one unknown point in the sample." In what follows we adopt their procedure: Among the various cases they analyze, we focus on the most general one.

Let X and Y be two nonstationary variables. Let the static equation

$$Y_t = a + bX_t + e_t, \quad t = 1,2, \ldots T \tag{1}$$

denote the traditional long-run model. If the error term e_t is a stationary process, then X and Y are cointegrated. We already know that this is not the case for crime and economic variables; in other words, model (1) is not adequate in the present analysis.

Now consider a possible shift occurring at time τ (with $1 < \tau < T$), and consider a dummy variable, D_t^τ, such that:

$$D_t^\tau = 0 \qquad \text{if } t < \tau$$

$$D_t^\tau = 1 \qquad \text{if } t \geqslant \tau$$

Let us consider now a model in which the regime shift implies a change of both the intercept and the slope of the cointegration relationship:

$$Y_t = a_0 + a_1 D_t^\tau + b_0 X_t + b_1 D_t^\tau X_t + e_t. \tag{2}$$

[10]See also Kremers et al. (1992) and Inder (1993).

TABLE 2. Breakpoint in cointegrating relationship between crime rate and economic variables

Variables	*Year*	*Z_t-statistics*
Homicide—Consumption	1964	−9.9622
Homicide—Unemployment (*)	1963	−6.6653
Homicide—Wealth	1963	−10.2393
Robbery—Consumption	1964	−5.0138
Robbery—Unemployment(**)	1970	−6.5908
Robbery—Wealth	1965	−8.1040
Theft—Consumption	1973	−5.4283
Theft—Unemployment	1969	−5.7649
Theft—Wealth	1974	−7.3273

Notes: The table shows the largest negative value of the Z_t statistics across all possible breakpoints occurring between 1955 and 1990. The critical value at the 5% critical level is −4.95; a larger negative value indicates that we can reject the null of the presence of a unit root in the e_t^τ series. The values shown refer to a window size equal to 14; the selected year does not change for window size equal to 12 or 10 (except in the starred cases). In the case (*), the minimum value of the Z_t at window size = 14 is reached in 1962 (Z_t = −6.88); window size = 10 suggests 1963 as the breakpoint, and the empirical performance of the latter cointegration relationship is better. In the case (**), the minimum value at window size = 14 is reached in 1962 (Z_t = −6.65), but 1970 is suggested as a breakpoint by choosing window size = 10, with better performance.

If e_t is stationary, we can say that X and Y cointegrate in the presence of a regime shift: In this case, the cointegrating vector has changed at time τ, with a_1 and b_1 measuring the change in the coefficients of the relationship since τ onward. Gregory and Hansen (1996) worked out a testing procedure for the endogenous determination of τ that was based on residuals of the relationships (2).

We have to consider all possible values of τ in the reasonable range $0.15T < \tau < 0.85T$; next, we compute the ADF-statistics and the Perron-Phillips Z_t-statistics based on the series e_t^τ (note that there are different residuals series for each τ); finally, we choose the value of τ that gives the largest negative level for such statistics across all possible breakpoints.

Gregory and Hansen (1996) provide the critical values for testing for the presence of a unit root in the residuals series. Although ADF and Z_t statistics have the same asymptotic distribution, the Z_t statistics perform better in small size samples, according to Montecarlo evidence.

In our specific case, we tried all possible breaks between 1955 and 1990 (our complete sample being 1951–1994). Table 2 reports the relevant breakpoint and the corresponding level of Z_t for each bivariate relationship.

The values of the Z_t-statistics in Table 2 clearly show that crime rates and economic variables cointegrate, with intercept and slope shifts. In the next step, we perform the cointegrating, long-run static regression with the regime shift, according to the collected evidence.

In each line of Table 3, we can read the cointegrating vector. The considered regression specifications correspond to equation (2). Coefficients a_1 and b_1 capture the shift in the constant term and in the slope-coefficient, respectively, so that $(a_0 + a_1)$ and

TABLE 3. Long-run static regression

Variable Y	*Variable X*	*Chosen* τ	a_0	a_1	b_0	b_1	R^2
LHP	*LCP*	1964	10.18 (6.54)	−14.41 (−8.50)	−0.83 (−4.23)	1.70 (8.14)	0.79
LHP	*LUR*	1963	4.58 (9.81)	0.69 (1.35)	0.37 (2.07)	0.29 (1.45)	0.63
LHP	*LWP*	1963	−0.66 (−0.08)	0.67 (0.09)	0.78 (0.55)	−0.22 (−0.15)	0.69
LRP	*LCP*	1964	6.11 (2.05)	−33.71 (−10.36)	−0.25 (−0.67)	3.98 (9.92)	0.96
LRP	*LUR*	1970	4.36 (7.67)	8.27 (11.42)	0.10 (0.48)	2.58 (9.34)	0.95
LRP	*LWP*	1965	−3.15 (−0.34)	−8.29 (0.90)	1.33 (0.79)	1.37 (0.81)	0.98
LTP	*LCP*	1973	1.73 (2.18)	6.53 (3.69)	0.87 (8.95)	−0.66 (−3.32)	0.96
LTP	*LUR*	1969	7.64 (16.81)	3.70 (6.48)	−0.40 (−2.39)	0.94 (4.34)	0.91
LTP	*LWP*	1974	−3.15 (−0.34)	−8.29 (−0.90)	1.33 (0.79)	1.37 (0.81)	0.97

Regression: $Y_t = a_0 + a_1 D_t^\tau + b_0 X_t + b_1 D_t^\tau X_t + e_t$.
Notes: t-Statistics are in parentheses (the asymptotic distribution of t is not standard).

$(b_0 + b_1)$ measure the level of coefficients in the cointegrating vector during the second subperiod (that is, the period after the break).

Notice that the explanations based on *LWP* are weaker in terms of statistical significance of the coefficients, with respect to the explanations involving *LCP* or *LUR*. This supports the common point of view suggesting a closer association of crime variables with unemployment and consumption (or disposable income) rather than with wealth.[11]

It is also important to note the instability in the coefficients of the cointegrating vector. In general, the long-run effects of economic variables on crime rates are stronger during the second subperiod than during the first one, as the level of $(b_0 + b_1)$ is always statistically significant. Both the homicide and the robbery rates are negatively related to consumption in the first period of the sample, whereas the sign of the relationship is reversed in the second period. As far as the theft rate is concerned, the opposite occurs: the higher the consumption level, the higher the theft rate during the first subperiod and the lower during the second part. Unemployment is related to theft and robbery negatively during the first subperiod and positively afterward; the relationship between the unemployment and the homicide rates presents a positive sign, with a particularly high elasticity in the second subperiod.

This wide variety of results is not at odds with economic explanations as, from a theoretical point of view, the impact of the economic activity is rather complex and several different links are conceivable. A high level of output, and/or consumption, and/or wealth means a high volume of commodities that potentially could be vulnerable, but it means also that there is a high probability of the lawful acquisition of commodities. A number of explanations can be considered also for the connections between unemployment and crime: An increase in the former variable means a drop in the opportunity for the lawful acquisition of commodities for workers out of the production process[12]; moreover, unemployed people have more "free time" to allocate

[11]People who commit crimes are more likely to be "liquidity constrained" than other people. In this case, the flow of income or consumption is the most relevant control variable.

[12]This is true especially for long-term unemployment. Long-term unemployment rates are particularly high and

to illegal activities. On the other hand, some specific types of crimes are more easily committed when agents are employed in legal activities.

It could be suggested that economic development can reduce crime rates in certain regions of the country. This "substitution" effect [or "motivation" effect, if we use the label suggested by Field (1990)] has been one of the political justifications for some programs of public investment. The effectiveness of such programs is very questionable. In fact, our evidence also provides limited support for the effectiveness of economic improvements in reducing crime rates. In the first half of the sample—before the break occurs—this mechanism seems to be at work only for homicides and robberies. On the contrary, the theft rate seems to be mainly determined by a different effect, i.e., the "temptation" (or "opportunity") effect: The more favorable economic conditions are (higher *per capita* consumption and/or lower unemployment rate), the higher the theft rate becomes. The picture changes after the break. The relevant distinction does not concern the different types of crimes; rather, the distinction concerns the economic variables. The unemployment rate gives rise to the "substitution" effect, whereas consumption produces the "temptation" effect. Once again, these observations make clear that no simple and unique explanation is possible for different crime phenomena.

Of course, our analysis does not consider explicitly variables such as the strength of the police force, the rate of convictions, the length of sentence, etc., that have been carefully investigated by more traditional structural studies. However, the available literature shows that economic explanations remain crucial even when additional regressors are considered [see, e.g., Field (1990); Reilly and Witt (1992); and Marselli and Vannini (1996, 1997)].

The Causality Analysis

From a theoretical point of view, there are several reasons for thinking that crime and economic activities are jointly determined. However, our previous interpretation of the cointegration relationships have relied upon an explanation of crimes by means of economic variables, even if we have not yet provided any empirical evidence about the causal links. This section offers support for such a view.

As a matter of fact, the cointegration analysis offers powerful tools to look at the causality issue. The representation theorem [Engle and Granger (1987)] states, loosely speaking, that a cointegration relationship can be represented as a model with error correction mechanism that entails (at least) one Granger causal ordering.

Let us consider the following system representing the short-run dynamics of the cointegrated variables X and Y, where Δ is the first-difference operator and EC denotes the error correction term, i.e., the fitted residuals of the static long-run regression corresponding to equation (2):

$$\Delta Y_t = \beta + \alpha EC_{t-1} + \sum_{i=1} \alpha_i \Delta Y_{t-1} + \sum_{j=1} \lambda_j \Delta X_{t-j} + \epsilon_t \tag{3a}$$

$$\Delta X_t = \phi + \gamma EC_{t-1} + \sum_{i=1} \gamma_i \Delta X_{t-1} + \sum_{j=1} \eta_j \Delta Y_{t-j} + \epsilon'_t \tag{3b}$$

persistent for specific groups of people. To our knowledge, the link between crime activity and long-term unemployment has not yet been analyzed.

TABLE 4. Long-run causality

Y/X	α	γ
LHP/LCP	−0.63 (−6.16)	−0.01 (−0.55)
LHP/LUR	−0.36 (−4.22)	+0.19 (2.11)
LHP/LWP	−0.43 (−4.80)	+0.02 (0.53)
LRP/LCP	−0.23 (−3.03)	+0.02 (1.15)
LRP/LUR	−0.19 (−2.73)	+0.09 (1.46)
LRP/LWP	−0.28 (−4.91)	+0.04 (1.15)
LTP/LCP	−0.41 (−2.74)	+0.23 (1.46)
LTP/LUR	−0.24 (−4.06)	+0.06 (0.79)
LTP/LWP	−0.35 (−2.94)	+0.09 (1.79)

Notes: The table reports the estimates of parameters α and γ in equations (3a) and (3b). *t*-Statistics are in parentheses.

There are different concepts of causality, with respect to system (3a, b). Long-run Granger causality refers to the links between the *levels* of Y and X [Granger and Lin (1995)]. The (weakly) exogenous variable is the variable for which the error correction coefficient is not significant in the explanation of the subsequent variation of the other variable. More clearly, if α is not different from zero, then we will say that Y is exogenous; if γ is not different from zero, X is exogenous. Of course, at least one long-run causal link must exist if variables cointegrate.

On the other hand, short-run Granger causality refers to the (stationary) variables ΔY and ΔX. In particular, ΔX is said to be weakly exogenous for the parameters of the regression (3b) if γ is not significantly different from zero. In this case, the estimation of regression (3a) becomes much simpler. Also, if coefficients η_j are not significantly different from zero, then there is no Granger causal link from ΔY to ΔX. In such a case, ΔX is *strongly* exogenous and (3a) can be used for prediction purposes.[13]

Table 4 reports the estimates for α and γ, for each pair of economic and crime variables, corresponding to our preferred specification, and in accordance with the significance of the terms of the lag-polinomials of ΔX and ΔY.[14] It is striking that, in all cases, economic variables seem to cause crime rates in the long-run, whereas crime rates do not cause economic variables.

To have a stable adjustment process of the variables toward their long-run levels, α and γ must lie in the interval $(-1, 0)$. All estimates of coefficient α satisfy this condition and are significant; this means that a smooth, stable, and significant adjustment process is taking place. By contrast, coefficient γ is never significantly negative; in fact, it is always not significant, except in one case (*LHP* with *LUR*) where it has the wrong sign. Thus, hereafter we can regard crime as being Granger caused by economic variables, whereas the converse is not true. As for the short-run causality issue, the results are equally clear cut: Economic variables are *strongly exogenous*.[15]

In what follows we look at the dynamic specification to obtain further information, especially about the short-run movements of the crime variables. More importantly, we

[13]Obviously the same holds, *mutatis mutandis*, for ΔX.

[14]In a few cases we add a single 1-year dummy.

[15]The results that refer to models with crime rates as dependent variables are shown in Tables 5, 7, and 9. The results that refer to models with crimes rates as independent variable are not reported, for the sake of brevity.

TABLE 5. Dynamic equation for homicide rate

	Model M1: $X = LCP$	Model M2: $X = LUR$	Model M3: $X = LWP$
Constant	−0.01 (−0.81)	−0.01 (−0.78)	−0.01 (−0.87)
$EC_{LHP,X}(-1)$	−0.63 (−6.16)	−0.36 (−4.22)	−0.43 (−4.80)
$\Delta LHP(-1)$	0.16 (1.55)	Not included	Not included
D_{91}	0.42 (5.58)	0.45 (5.10)	0.45 (5.34)
R^2	0.63	0.48	0.53
D-W [Durbin's h]	1.71 [1.24]	1.51	1.69

Dependent variable: ΔLHP_t

Note: *EC* denoted the residuals of the long-run static regression (2). (−1) indicates lagged value. D_{91} denotes a one-year dummy for 1991. *t*-Statistics are in parenthesis.

TABLE 6. Encompassing tests on non-nested models M1, M2, and M3 for homicide rate

	M1 v. M2	*M2 v. M1*	*M2 v. M3*	*M3 v. M2*	*M1 v. M3*	*M3 v. M1*
NT-test	0.31 [0.758]	−4.65 [0.000]	−2.61 [0.009]	−1.09 [0.276]	−0.37 [0.712]	−3.83 [0.000]
W-test	0.31 [0.754]	−3.75 [0.000]	−2.32 [0.020]	−1.03 [0.301]	−0.36 [0.717]	−3.16 [0.002]
J-test	−0.26 [0.793]	4.03 [0.000]	2.18 [0.029]	1.05 [0.291]	0.41 [0.681]	3.44 [0.001]
Encompassing	$F_{1,37} = 0.07$ [0.795]	$F_{2,37} = 7.93$ [0.001]	$F_{1,39} = 4.76$ [0.035]	$F_{1,39} = 1.11$ [0.298]	$F_{1,37} = 0.17$ [0.683]	$F_{2,37} = 5.79$ [0.006]
Akaike	6.45 (favors M1)		−1.87 (favors M3)		4.62 (favors M1)	
Schwarz	5.58 (favors M1)		−1.87 (favors M3)		3.75 (favors M1)	

Note: The NT-test is the adjusted Cox test, and the W-test is the Wald-type test, due to Godfrey-Pesaran; the J-test is the Davidson-MacKinnon test; the encompassing test is a F-type test due to Mizon-Richard; cf. Pesaran-Pesaran (1991). Akaike stands for Akaike's Information Criterion, and Schwarz stands for Schwarz information criterion. *p*-Values are reported in brackets.

TABLE 7. Dynamic equation for robbery rate

	Model M4: $X = LCP$	Model M5: $X = LUR$	Model M6: $X = LWP$
Constant	0.04 (2.09)	0.04 (1.99)	0.04 (2.12)
$ECM_{LRP,X}(-1)$	−0.23 (−3.03)	−0.19 (−2.73)	−0.29 (−2.91)
$\Delta LRP(-1)$	0.37 (2.81)	0.41 (2.99)	0.33 (2.49)
R^2	0.30	0.27	0.29
D-W [Durbin's h]	2.12 [−0.44]	2.11 [−0.41]	2.16 [−0.69]

Dependent variable: ΔLRP_t

See Note in Table 5.

TABLE 8. Encompassing tests on non-nested models M4, M5, and M6 for robbery rate

	M4 v. M5	*M5 v. M4*	*M5 v. M6*	*M6 v. M5*	*M4 v. M6*	*M6 v. M4*
NT-test	−1.33 [0.183]	−2.11 [0.035]	−3.40 [0.001]	−2.87 [0.004]	−1.13 [0.260]	−1.44 [0.148]
W-test	−1.27 [0.204]	−1.97 [0.049]	−3.14 [0.002]	−2.68 [0.007]	−1.08 [0.280]	−1.37 [0.170]
J-test	1.27 [0.204]	1.76 [0.079]	2.25 [0.024]	2.03 [0.042]	1.12 [0.260]	1.36 [0.173]
Encompass.	$F_{1,38} = 1.62$ [0.211]	$F_{1,38} = 3.03$ [0.087]	$F_{1,38} = 5.07$ [0.030]	$F_{1,38} = 4.14$ [0.049]	$F_{1,38} = 1.27$ [0.267]	$F_{1,38} = 1.85$ [0.181]
Akaike	0.768 (favors M4)		−0.457 (favors M6)		0.311 (favors M4)	
Schwarz	0.768 (favors M4)		−0.457 (favors M6)		0.311 (favors M4)	

See Note in Table 6.

rely on these specifications to choose the most appropriate economic explanatory factor for each crime type.

The Dynamic Specification Analysis

Tables 5, 7, and 9 report the results of regression analyses based on equation (3a). The proposed specification for each case corresponds to the optimal one (in a statistical sense), using a "general to specific" approach. It is worth noting that the variables ΔX_t and ΔX_{t-1} are never significant and that the period-dummy variables D_t^{τ} are never necessary (though in some cases they would lead to a higher R^2); this means that the break occurring in the cointegrating relationship does not imply a break in the adjustment process. Tables 6, 8, and 10 report encompassing tests on the alternative models for each type of crime.

As for the homicide rate, note that a dummy variable corresponding to 1991 is necessary to wash out the influence of this outlier year. The results of encompassing tests are clear: The explanation based on consumption is the best one. Intuitively, we can order the three models as follows, with $\mathcal{P}$ denoting the transitive relation "is preferred to . . . (on the basis of statistical criteria)": $M1 \ \mathcal{P} \ M3 \ \mathcal{P} \ M2$. It must be noted that the preference order would not change if we omitted ΔLHP_{t-1} from regression $M1$.

Let us consider the robbery rate (Tables 7 and 8). The variable ΔLRP_{t-1} is always significant, and this suggests a certain degree of persistence in the percentage of change

TABLE 9. Dynamic equation for theft rate

	Model M7: X = LCP	*Model M8: X = LUR*	*Model M9: X = LWP*
Constant	0.02 (0.99)	0.02 (1.80)	0.02 (1.25)
$EC_{LRP,X}(-1)$	−0.41 (−2.74)	−0.24 (2.10)	−0.35 (−2.94)
$\Delta LTP(-1)$	0.36 (2.31)	0.24 (2.10)	0.42 (3.12)
D_{91} (or $D_{73}{}^{\#}$)	$0.28^{\#}$ (2.30)	0.32 (3.90)	0.31 (3.60)
R^2	0.23	0.50	0.41
D-W [Durbin s h]	2.06 [−0.87]	1.86 [0.65]	1.68 [1.60]

Dependent variable: ΔLTP_t

Note: EC denotes the residuals of the long-run static regression; (−1) indicates lagged value; D_{91} (or D_{73}) denotes a 1-year dummy for 1991 (or 1973). *t*-Statistics are in parentheses.

TABLE 10. Encompassing tests on non nested models M7, M8, and M9 for the theft rate

	M7 v. M8	*M8 v. M7*	*M8 v. M9*	*M9 v. M8*	*M7 v. M9*	*M9 v. M7*
NT-test	−8.04 [0.000]	−1.82 [0.069]	−0.99 [0.322]	−3.90 [0.000]	−6.09 [0.000]	−1.79 [0.073]
W-test	−6.18 [0.000]	−1.72 [0.086]	−0.95 [0.342]	−3.40 [0.001]	−5.01 [0.000]	−1.69 [0.090]
J-test	4.99 [0.000]	1.88 [0.060]	1.00 [0.315]	2.71 [0.007]	4.30 [0.000]	2.16 [0.030]
Encompass.	$F_{2,36} = 12.32$ [0.000]	$F_{2,36} = 1.82$ [0.176]	$F_{1,37} = 1.01$ [0.322]	$F_{1,37} = 7.35$	$F_{2,36} = 9.12$ [0.001]	$F_{2,36} = 2.69$ [0.081]
Akaike	−8.92 (favors M8)		3.24 (favors M8)		−5.68 (favors M9)	
Schwarz	−8.92 (favors M8)		3.24 (favors M8)		−5.68 (favors M9)	

See Note in Table 6.

in the robbery ratio. No 1-year or period dummy is included in our preferred specification.[16] As to the ranking among the models, it can be summarized by: $M4 \mathcal{P} M6 \mathcal{P} M5$. It led us to choose consumption as the more relevant single economic explanatory factor. However, the preference ordering is a little less strong (in terms of statistical criteria) than in the case of homicides and thefts, as we will see. The size of the *EC* terms in Table 7 suggests a slower adjustment process with respect to homicides (Table 5) and thefts (Table 9). Also, the precision of the estimates of the long-run coefficients is lower in the case of robbery (as shown by Table 3). We may conclude that the influence of the economic conditions on this type of crime is weaker than in the cases of homicide or theft, perhaps because of the importance of “learning by doing” phenomena.

The results of the theft ratios are shown in Tables 9 and 10. The summary of the encompassing tests is: $M8 \mathcal{P} M9 \mathcal{P} M7$. The strongest link seems to exist between unemployment and theft. Once again, it has to be stressed that different specifications, especially for the regression connecting the consumption and theft rates, do not give different conclusions concerning the speed of convergence to equilibrium and concerning the degree of persistence—even if the inclusion of additional dummy variables can slightly improve the R^2 level.[17]

Summing up, financial wealth is never preferred as the most appropriate single explanatory factor; consumption is the “best” regressor for the homicide and robbery rates, whereas unemployment is preferred for the theft rate.

The same conclusions arise from the regressions in Table 11 in which the crime rates are simultaneously regressed against the residuals of the long-run regression with consumption and the residuals of the long-run regression with unemployment. The coefficient of the error-correction term for consumption is more precisely estimated than the coefficient of the error-correction term for unemployment in the cases of homicide and robbery, whereas the opposite holds for the theft ratio. This evidence can be interpreted as a test on nested models, supporting the same conclusions reached by the previous, more traditional, procedures.

When the evidence regarding the long-run links between economic variables and crime ratios is coupled with the short-run adjustment dynamics, the picture can be summarized

[16]Our regression strategy led us to consider symmetric specification among competing models, when possible; dummy variables are included only when statistically significant and relevant on the overall regression performance. For instance, the inclusion of the period dummy D_{1970} in model *M5* would increase R^2 by 12%, but it would not change the main features of the adjustment process.

[17]The inclusion of both the 1991 dummy and the 1973 dummy in M7 would lead to $R^2 = 0.43$; in M9 the inclusion of the period-dummy D_{1974} would improve the R^2 level to 0.55.

TABLE 11. An encompassing test on nested models

	ΔY; $Y = LHP$	ΔY; $Y = LRP$	ΔY; $Y = LTP$
Constant	0.001 (0.07)	0.04 (2.07)	0.03 (1.85)
$EC_{Y,LCP}(-1)$	−0.73 (−3.19)	−0.16 (1.76)	−0.10 (−0.75)
$EC_{Y,LUR}(-1)$	0.14 (0.76)	−0.11 (−1.27)	−0.23 (−3.15)
$\Delta Y(-1)$	0.22 (1.58)	0.39 (2.97)	0.27 (1.79)
R^2	0.34	0.33	0.30
D-W [Durbin's h]	2.08 [−0.29]	2.07 [−0.28]	2.25 [1−49]

Dependent variable is ΔY, with $Y = LHP, LRP, LTP$.

Note: EC indicates the residuals of the static long-run regression of the crime rate against the economic variable, corresponding to equation (2). t-Statistics are in parentheses.

as follows. The "long-run equilibrium levels" of the homicide rate and the robbery rate are determined mainly by the level of consumption *per capita*; the sign of such a link was negative till the mid-1960s (the higher the level of *per capita* consumption, the lower these crime rates), and was positive thereafter. On the other hand, the "long-run equilibrium level" of the theft rate is mainly determined by unemployment: until the end of the 1960s, the higher the unemployment rate, the lower the theft ratio, and the opposite was true afterward. In all cases, the size of the effect of the economic variables on the crime rates is larger in the second subperiod than in the first one. In the short-run, there is a certain degree of persistence in the dynamics of crime ratios. Interestingly, persistence is lower in the case of homicide than in the cases of robbery and theft; this seems to be consistent with the different nature of these crimes. Moreover, the (contemporaneous and lagged) rate of change of economic variables does not affect significantly the dynamics of crime rates. The largest effect of the economy on criminality seems to arise from the adjustment process, which leads the current level of crime rates to move toward its "long-run equilibrium level." More generally, the rate of change in crime ratios is not correlated with the rates of change of the economic variables considered in our paper: in eight of nine cases, the simple correlation coefficients are not significant.[18] This evidence, once again, enables us to suggest that the attention on the short-run relation between economic activities and crime (which characterizes most of the available studies) is perhaps excessive and that more attention must be paid to the long-run links.

IV. Conclusions

This paper has followed a data-oriented approach to evaluate which economic variable better explains the "long-run equilibrium level" of crime in Italy over the period from 1951 to 1994. We have considered the rates of homicides, robberies, and thefts, on one side, and of consumption, unemployment, and private nonhuman wealth, on the other side.

The focus on the long-run relationship between crime rates and economic variables makes this paper different from a large part of the economic literature about crime, which focuses on the short-run business cycle links. Nonetheless, the complex interpretations suggested by the available studies—calling for "motivation effects," "opportunity effects," and "lifestyle effects" in the explanation of crime—can hold to the long-run analysis as well. We have applied the tools provided by cointegration analysis

[18]The only exception is the correlation between Δ LRP and Δ LWP, which is equal to 0.32 ($t = 2.14$).

in the presence of a possible regime shift. The procedure has allowed us to detect the break-point endogenously.

The main point of the article concerns the evidence for a cointegrating relationship of each crime variable with one economic factor. Such cointegrating relationships do not emerge if regime shifts are not considered.

Generally speaking, the regime shifts occurred in the middle or end of the 1960s. After the breaks, the effects of economic variables on crime rates have been stronger.

Of course, this atheoretical approach prevents us from offering strong economic explanations for such regime shifts. Institutions, along with the social and cultural environment, should be considered in a complete structural model. In the case of Italy, furthermore, the differences among regions can offer important insights.

In conclusion, we are aware of the restricted perspective of the present analysis: Crime is a complex phenomenon, and economic factors represent only a partial explanation. Nevertheless, the long-run pattern of economic variables clearly affect (in a statistical sense) the long-run pattern of crime activities.

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