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THEORY AND TIME-SERIES EVIDENCE

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**ABSTRACT**

The aim of this paper is to examine the impact of labor market conditions, represented by male civilian unemployment rates, on seven major categories of crime. We propose a theoretical model from which the positive macro relationship between the unemployment rate and the crime rate is explicitly derived. The solution of the proposed model shows the concurrent counter-cyclical movements of the unemployment and crime rates, which is found to be consistent with the U.S. time series data from the first quarter of 1970 to the fourth quarter of 1983. Thus, we propose a view that an increase in the unemployment rate triggers a subsequent increase in the crime rate. Further, we find that the unemployment rate is statistically exogenous in the VAR model, which indicates a fact that there lie the economic forces and motivations behind the positive relationship between the unemployment rate and the crime rate.

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## I. Introduction

Since the seminal work of Becker(1968), there have been, in studies of the economics of crime, a considerable number of theoretical and empirical analyses of the effects of legal sanctions on criminal activities. While most previous empirical studies agree on the deterrent effects of legal sanctions on crime<sup>1</sup>, there is as yet no definitive statement about the effects of labor market conditions on the crime rate. The sign of the unemployment rate - crime rate relation and its statistical significance surprisingly vary from one empirical study to another. If there is an unemployment rate effect on the crime rate, the spillover effect is too important for makers of public policy to ignore. Therefore, the empirical relationships between labor market conditions and the crime rate deserve more careful attention and clarification.

The theories remain unsatisfactory, too. Traditional economic theories of crime - namely the analyses of individual time allocations between legal and illegal activities(Heineke 1978, Schmidt and Witte 1984) - do not explain explicitly why some commit crimes while others obey the law. Further, these microeconomic analyses do not produce a plausible macro-relation between the unemployment rate and the crime rate, that can be estimated with given aggregate data without unreasonably strong assumptions. To overcome these shortcomings of the traditional models, in our view, a theory should restrict the preferences of criminals so as to make them distinctive from non-criminals, and a theory should yield an explicit macro-relation between the unemployment and crime rates. Our model is built upon this recognition.

As for the previous empirical studies on the relationship between the labor market conditions and the crime rate, we find three major econometric drawbacks. First, much of the empirical work of crime supply functions is a single equation model, confronted with the problem of identification. Their econometric results appear to be unreliable. Second, most of the empirical models do not allow for lagged effects of the unemployment rate on the crime rate which behaves counter-cyclically over the business cycles.<sup>2</sup> Third, the models are unlikely to be free of a strong multicollinearity between the

unemployment rate and other explanatory variables, e.g., income distribution and wages. For example, unemployment usually affects unskilled workers, minority groups, and secondary workers, and therefore exacerbates income inequality. Also, a given level in the unemployment rate influences not only the rate of change, but also the level of wage rates in the labor market.

The purpose of this study is to make explicit the interactions between the unemployment and crime rates, both theoretically and empirically. We consider the above drawbacks primarily responsible for the inconclusive empirical results in past analyses of the unemployment rate - crime rate relation. In order to circumvent the statistical problems mentioned before, we use advanced econometric techniques developed by Granger(1969) and Sims(1980), specifically a vector autoregressive model as a complementary approach to the previous empirical studies of the structural models. This methodology is intuitively appealing since the econometric techniques, in our study, show the significance of the relationship between the unemployment and crime rates as well as the timing of changes in the crime rate in response to changes in the unemployment rate.<sup>3</sup>

In this study, we re-examine the relationships between the unemployment rate and the rates of the seven categories of crime: murder, rape, robbery, aggravated assault, burglary, larceny-theft, and motor vehicle theft.<sup>4</sup> The period of analysis is from the first quarter of 1970 to the fourth quarter of 1983. There are a number of reasons for choice of this time span. First, during this period, there have been significant fluctuations in male civilian unemployment rates for almost all age groups. Second, the crime rates mentioned above all experienced a rapid rise for all but the final three years.<sup>5</sup> Finally, few empirical studies on the unemployment rate - crime rate relation have covered the period we analyze.

The organization of the subsequent parts of this study is as follows: Section II presents our model, characterizing behavior of the criminals, from which the macro-positive relation between the unemployment and crime rates is explicitly derived. Section III introduces our vector autoregressive model, and reports the empirical results. Finally, Section V gives the conclusion of this study.

## II. The Model

At first, a broad outline of the proposed model is shortly introduced: As we will focus on the individual differences in preferences, we make each individual's choice problem as simple as possible. Then, we will select the parameters characterizing individual preferences, and those parameters are the most relevant to our present purposes. Individual differences are to be expressed by the differences in the relevant parameters, and it will be shown that the parameters, criminals share, are distinctive from the non-criminals. In other words, the solution of the proposed model characterizes the personal traits of the criminals as highly risk-loving and by the strong preference for leisure. Considering the distribution of the relevant parameters over total population, one can calculate the relative numbers(or proportions) of the criminals, the employed, and the unemployed given the wage level of the employed and other exogenous variables. The changes in the wage level of the employed affect, of course, the relative number of the criminals and that of the unemployed. If the wage level of the employed decreases, the less risk-loving individuals, for example, participate in the illegal activities, and the overall crime rate increases. Below, we will explain the above supposed interactions between the crime rate and the labor market conditions more fully.

### II-1 Labor Demand Side

The demand for labor in this economy is defined by,

$$D^1 = H(W^1) + G^1 = N + G^1, \quad (1)$$

where  $W^1 = F_1(N; K)$  and  $H(W^1) = F_1^{-1}(W^1)$ ;  $N$  is labor employed in the private sector;  $F$  the production function;  $K$  the given stock of capital;  $W^1$  is the wage level of the employed, and  $G^1$  represents the government demand for labor and is an exogenous policy variable. We assume the production function is well-behaved, and  $H' = \partial H / \partial W^1 < 0$ . In this model, the upward facet of the business cycle will be described by a rise in  $G^1$ .

Further, we assume the government total expenditure on the unemployment allowances ( $G^2$ ) is exogenously fixed such that;

$$W^2 S^2 = G^2, \quad (2)$$

where  $S^2$  is the number of the unemployed who receive the unemployment allowances, and  $W^2$  is the amount of the unemployment allowances.

### II-2 Labor Supply Side

We assume: (i) an individual in the labor market faces institutionally fixed working hours (e.g., via labor market contractual restrictions); (ii) an employed individual in the labor market does not commit a crime, and (iii) an individual who commits a crime does not (or can not) receive his or her unemployment allowances. Then, each individual faces the following three alternative choices.

(1) an individual can be employed for the fixed  $H$  hours, and obtain utility;

$$U_i(W_i^1) - V_i(H), \quad (3)$$

where  $U$  and  $V$  are monotonically continuous and at least twice differentiable functions;  $V$  is disutility from work.<sup>6</sup> We can define  $\hat{W}_i^1$  for the individual  $i$  such that,

$$U_i(\hat{W}_i^1) - V_i(0) = U_i(W_i^1) - V_i(H). \quad (4)$$

Assuming  $V_i(0) = 0$  for all  $i$ , it follows that if  $\hat{W}_i^1 < W^2$ , one will be voluntarily unemployed.

(2) The individual could decide to be unemployed and receive unemployment allowances  $W^2$ , and obtains utility  $U_i(W^2)$ .

(3) The individual can commit a crime ( $C$ ), and his or her expected utility from committing a crime is defined by,

$$EU_i(C) = pU_i(-A) + (1 - p)U_i(W^3), \quad (5)$$

where  $p$  is a fixed probability of being apprehended and punished;  $A$  is the money equivalent of the punishment for crime; and  $W^3$  is the money equivalent

of the benefit from the illegal activity. Again, we can define the certainty equivalent of the expected pecuniary (money-evaluated) benefit from a crime,  $\hat{W}_1^3$ , by

$$U_1(\hat{W}_1^3) = pU_1(-A) + (1 - p)U_1(W^3). \quad (6)$$

Now, if  $\hat{W}_1^1$  (which is increasing in  $W^1$ ) is larger than  $\max(W^2, \hat{W}_1^3)$ , one will be employed in the market. From (4) and (6), we know that  $\hat{W}_1^1$  is a function of the parameter  $\phi_1$  (representing preference for leisure), and  $\hat{W}_1^3$  is a function of the parameter  $R_1$  (representing the degree of (constant) risk-aversion). Thus, we may define,

$$\hat{W}_1^1 = \hat{W}_1^1(\phi_1; W^1), \quad \partial \hat{W}_1^1 / \partial \phi_1 < 0 \quad \phi_1 \in [\phi_v, \phi_u], \quad (7)$$

$$\hat{W}_1^3 = \hat{W}_1^3(R_1; p, A, W^3), \quad \partial \hat{W}_1^3 / \partial R_1 < 0 \quad R_1 \in [R_v, R_u]. \quad (8)$$

Then, (A) one will be employed if  $\hat{W}_1^1(\phi_1) > \hat{W}_1^3(R_1)$  and  $\hat{W}_1^1(\phi_1) > W^2$ ;

(B) one will be unemployed if  $W^2 > \hat{W}_1^1(\phi_1)$  and  $W^2 > \hat{W}_1^3(R_1)$ ; and

(C) one will commit a crime if  $\hat{W}_1^3(R_1) > W^2$  and  $\hat{W}_1^3(R_1) > \hat{W}_1^1(\phi_1)$ .<sup>7</sup>

These conditions can be expressed in terms of only  $R_1$  and  $\phi_1$ , which would be more useful for our present purposes. First, we define the critical points  $\bar{R}$  and  $\bar{\phi}$  by

$$W^2 = \hat{W}_1^3(\bar{R}) = \hat{W}_1^1(\bar{\phi}). \quad (9)$$

Further, we define  $\bar{R}$  and  $\bar{\phi}$  by,

$$\hat{W}_1^3(R_v) = \hat{W}_1^1(\bar{\phi}), \quad \hat{W}_1^1(\phi_v) = \hat{W}_1^3(\bar{R}), \quad (10)$$

and, here we assume  $\bar{R} < R_v$ , which implies  $\bar{\phi} > \phi_v$  (thus, though  $\bar{R}$  can be defined theoretically as above, we assume no individual has a parameter  $\bar{R}$ ). For discussions to follow, we confirm the following relations,

$$\partial \bar{\phi} / \partial W^1 > 0, \quad \partial \bar{\phi} / \partial W^1 > 0, \quad \partial \bar{\phi} / \partial W^2 < 0, \quad \text{and} \quad \partial \bar{R} / \partial W^2 < 0. \quad (11)$$

Figure 1(A) explains the workings of the proposed model, wherein one could confirm the definitions of the critical values of  $\hat{R}$ ,  $\hat{\phi}$ , and of  $\bar{\phi}$ . An increase in the market wage rate from  $W^1$  to  $W^{1'}$  shifts  $\hat{W}^1$ -curve outward, because  $\partial \hat{W}_i^1 / \partial W^1 > 0$  for all  $i$  in (4). It is evident in the Figure that an increase in  $W^2$  decreases both  $\hat{R}$  and  $\hat{\phi}$ .

Now, the condition B above is equivalent to [see (7), (8)],

$$R_i > \hat{R} \text{ and } \phi_i > \hat{\phi}, \quad (12)$$

which shows the personal characteristics of the unemployed. From C above, we know that all the criminals are characterized by  $R_i < \hat{R}$  (i.e., they are highly risk-loving), and  $\min. \hat{W}^3(R_i) = \hat{W}^3(\hat{R})$ ,  $\max. \hat{W}^3(R_i) = \hat{W}^3(R_V)$  for the criminals. Thus, we know that the necessary conditions (the conditions for  $\hat{W}^3(\hat{R}) > \hat{W}^1(\phi_i)$ ,  $R_i < \hat{R}$ ) to become a criminal are,

$$R_i < \hat{R} \text{ and } \phi_i > \hat{\phi}, \quad (13)$$

and the sufficient conditions (i.e., the conditions for  $\hat{W}^3(R_V) > \hat{W}^1(\phi_i)$ ,  $R_i < \hat{R}$ ) are

$$R_i < \hat{R} \text{ and } \phi_i (> \hat{\phi}) > \bar{\phi}. \quad (14)$$

In Figure 1(B), the shaded area represents the minimum number of the criminals, and the dotted area the maximum number of the criminals. In the same way, we can figure out the necessary conditions to be employed as follows,

$$R_i > \hat{R} \text{ and } \bar{\phi} < \phi_i < \hat{\phi}, \text{ or } \phi_i < \bar{\phi}, \quad (15)$$

and the sufficient conditions as follows,

$$\phi_i < \bar{\phi}^8. \quad (16)$$

We assume  $\phi_i$  and  $R_i$  are independently distributed by the density functions of  $\Gamma_{\phi}$  and  $\Gamma_R$ , respectively. Then, normalizing total population as



1, the supply of the employed( $S^1$ ), the unemployed( $S^2$ ) and the criminals( $S^3$ ) are calculated as,

$$\min.S^1 = \int_{R_V}^{R_U} \Gamma_R dR_1 \int_{\phi}^{\phi_u} \Gamma_{\phi} d\phi_1 + \int_{\phi}^{\bar{\phi}} \Gamma_{\phi} d\phi_1, \quad (17)$$

$$\max.S^1 = \int_{\phi}^{\bar{\phi}} \Gamma_{\phi} d\phi_1, \quad (18)$$

$$S^2 = \int_{R_V}^{R_U} \Gamma_R dR_1 \int_{\phi}^{\phi_u} \Gamma_{\phi} d\phi_1, \quad (19)$$

$$\min.S^3 = \int_{R_V}^{R_U} \Gamma_R dR_1 \int_{\phi}^{\phi_u} \Gamma_{\phi} d\phi_1, \quad (20)$$

$$\max.S^3 = \int_{R_V}^{R_U} \Gamma_R dR_1 \int_{\phi}^{\phi_u} \Gamma_{\phi} d\phi_1. \quad (21)$$

(19) is obtained from (12), and  $\min.S^i (i = 1, 3)$  is the proportion corresponding to the necessary conditions given, respectively, in (13) and (15). In the same way,  $\max.S^i (i = 1, 3)$  is the proportion corresponding to the sufficient conditions in (14) and (16).

The proposed model can not predict the choice of the individuals characterized by  $R_1 < \bar{R}$  and  $\bar{\phi} < \phi_1 < \hat{\phi}$  (whether employed or commit crimes).

See that total population is given by  $1 = S^2 + \min.S^3 + \min.S^1 + Re.$  ( $Re. = \int_{R_V}^{R_U} \Gamma_R dR_1 \int_{\phi}^{\bar{\phi}} \Gamma_{\phi} d\phi_1$ ; those not characterized and not counted.  $Re.$  is an abbreviation for residual), or  $1 = S^2 + \max.S^3 + \max.S^1 - Re.$  (those not characterized and double counted).

Without losing generality, we will represent  $S^1$  by  $\min.S^1$ , and  $S^3$  by  $\min.S^3$  (readers would note that  $\min.S^i$  and  $\max.S^i$  reveal the same responses to the changes in  $W^1$  and  $W^2$ ,  $i = 1, 3$ ). Now, from the above discussions, followings are easily obtained,

$$\partial S^1 / \partial W^1 = \Gamma_{\phi}(\hat{\phi}) \int_{R_V}^{R_U} \Gamma_R dR_1 (\partial \hat{\phi} / \partial W^1) + \Gamma_{\phi}(\hat{\phi}) \int_{R_V}^{R_U} \Gamma_R dR_1 (\partial \hat{\phi} / \partial W^1) \quad (22)$$

$$\partial S^1 / \partial W^2 = \Gamma_{\phi}(\hat{\phi}) \int_{\bar{R}}^R u_{\bar{R}}^R dR_{\bar{1}} (\partial \hat{\phi} / \partial W^2) - \Gamma_{\bar{R}}(\bar{R}) \int_{\hat{\phi}}^{\bar{\phi}} \Gamma_{\phi} d\phi_{\bar{1}} (\partial \bar{R} / \partial W^2) \quad (23)$$

$$\partial S^2 / \partial W^1 = -\Gamma_{\phi}(\hat{\phi}) \int_{\bar{R}}^R u_{\bar{R}}^R \Gamma_{\bar{R}} dR_{\bar{1}} (\partial \hat{\phi} / \partial W^1) \quad (24)$$

$$\partial S^2 / \partial W^2 = -\Gamma_{\phi}(\hat{\phi}) \int_{\bar{R}}^R u_{\bar{R}}^R dR_{\bar{1}} (\partial \hat{\phi} / \partial W^2) - \Gamma_{\bar{R}}(\bar{R}) \int_{\hat{\phi}}^{\bar{\phi}} u_{\phi}^{\phi} d\phi_{\bar{1}} (\partial \bar{R} / \partial W^2) \quad (25)$$

$$\partial S^3 / \partial W^1 = -\Gamma_{\phi}(\hat{\phi}) \int_{\bar{R}_V}^{\bar{R}} \Gamma_{\bar{R}} dR_{\bar{1}} (\partial \hat{\phi} / \partial W^1) \quad (26)$$

$$\partial S^3 / \partial W^2 = -\Gamma_{\phi}(\hat{\phi}) \int_{\bar{R}_V}^{\bar{R}} \Gamma_{\bar{R}} dR_{\bar{1}} (\partial \hat{\phi} / \partial W^2) + \Gamma_{\bar{R}}(\bar{R}) \int_{\hat{\phi}}^{\bar{\phi}} u_{\phi}^{\phi} \Gamma_{\phi} d\phi_{\bar{1}} (\partial \bar{R} / \partial W^2) \quad (27)$$

In the above, one would confirm that,

$$\sum_{i=1}^3 (\partial S^i / \partial W^j) + \partial Re. / \partial W^j = 0, \quad j = 1, 2. \quad (28)$$

It is apparent that (24) and (26) are negative, and (22) and (25) are positive. The signs of (23) and (27) can not be determined without further restrictions. Here, we assume that  $\bar{R}$  is sufficiently small, and  $\bar{\phi}$  is sufficiently large (i.e., criminals share rather exceptional personal traits defined in terms of the parameters of  $R$  and  $\phi$ ), and therefore,  $\int_{\bar{R}}^R u_{\bar{R}}^R dR_{\bar{1}}$  is

sufficiently larger than  $\int_{\hat{\phi}}^{\bar{\phi}} u_{\phi}^{\phi} d\phi_{\bar{1}}$ . More exactly, we assume,

$$\int_{\bar{R}}^R u_{\bar{R}}^R dR_{\bar{1}} > \xi \int_{\hat{\phi}}^{\bar{\phi}} u_{\phi}^{\phi} d\phi_{\bar{1}},$$

where  $\xi = [(\partial \bar{R} / \partial W^2) / (\partial \hat{\phi} / \partial W^2)] [\Gamma_{\bar{R}}(\bar{R}) / \Gamma_{\phi}(\hat{\phi})]$ . Then, (23) becomes negative. To determine the sign of (27) theoretically, we add following assumptions. That is, we assume that (a) the proportion of residual  $Re.$  is sufficiently small, and  $\partial Re. / \partial W^2$  is negligible, (b)  $\partial S^2 / \partial W^2$  (say, the direct effect of an increase in  $W^2$ ) is larger than  $\partial S^1 / \partial W^2$  (the indirect effect).<sup>9</sup> Then, (27) must be negative to satisfy the relation (28).

III-3 Labor Market Equilibrium.

Now, the labor market equilibriums are defined by

$$\begin{matrix} S^1(W^1 W^2) = D^1(W^1), & (29) \\ + & - & - \end{matrix}$$

$$\begin{matrix} W^2 S^2(W^1 W^2) = G^2. & (30) \\ - & + \end{matrix}$$

From these relations,  $W^1$  and  $W^2$  are endogenously determined, and then, given  $W^1$  and  $W^2$  (and thus,  $\hat{\phi}$ ,  $\hat{R}$ ,  $\hat{\phi}$ ), the labor allocation over the three activities are determined in (17) - (21). We omit the discussions on the existence and uniqueness of the equilibrium in this model (which are intuitively clear as the functions we defined in the model are all well-behaved), and examine the effects of the exogenous increase in  $G^1$  on the labor supplies to each activity. From (1), (2), (29), and (30), we obtain,

$$\begin{pmatrix} S_1^1 - H' & S_2^1 \\ W^2 S_1^2 & S^2 + W^2 S_2^2 \end{pmatrix} \begin{pmatrix} dW^1 \\ dW^2 \end{pmatrix} = \begin{pmatrix} dG^1 \\ dG^2 \end{pmatrix} \quad (31)$$

where  $S_j^i$  means  $\partial S^i / \partial W^j$ ,  $i, j = 1, 2, 3$ . The determinant of the above system is,

$$\Delta = S_1^1 S^2 - H' (S^2 + W^2 S_2^2) + W^2 (S_1^1 S_2^2 - S_2^1 S_1^2), \quad (32)$$

which is positive under our assumption of  $1 > (S_2^1/S_2^2)(S_2^2/S_1^1)$  [see fn.9].

Then, we obtain the comparative statics results as follows,

$$\partial W^1 / \partial G^1 = (S^2 + W^2 S_2^2) / \Delta > 0 \quad (33)$$

$$\partial W^2 / \partial G^1 = -S_2^1 / \Delta > 0 \quad (34)$$

and,

$$\partial S^i / \partial G^1 = [S_1^i (S^2 + W^2 S_2^2) - S_2^1 S_2^i] / \Delta, \quad i = 1, 2, 3. \quad (35)$$

Comparing (19) and (23), we know that  $S^2 > S_2^1$ , and therefore,  $S^2 + W^2 S_2^2 > S_2^1$ , and  $-S_2^1 S^2 > -S_2^2 S_2^1$ . Thus,  $\partial S^1 / \partial G^1$  is positive, while  $\partial S^2 / \partial G^1$  and  $\partial S^3 / \partial G^1$  are negative.

From these results, we know that  $S^2$  and  $S^3$  move in the same direction to the changes in  $G^1$ , and the crime rate  $S^3$  behave counter-cyclically over the business cycles (recall our assumption that a rise in  $G^1$  reveals the upward facet of the business cycle, and vice versa). To empirically implement this result to our time series analysis, we use a vector autoregressive model, which will highlight the unemployment rate's lagged effects on the crime rate, and the concurrent counter-cyclical movements of the unemployment and the crime rates (and thus, the positive relationships between the two rates).

### III. Empirical Specification and Results.

#### III-1 Vector Autoregressive Model

A vector autoregressive model (VAR) will show the statistical relevance and causal relationships between criminal activities and the condition of labor market, i.e., being unemployed. The VAR is defined as follows:

$$CR(t) = a_0 + \sum_{s=1}^m a(s)CR(t-s) + \sum_{j=1}^4 \sum_{s=1}^m b_j(s)UN_j(t-s) + e(t) \quad (36)$$

and,

$$UN_j(t) = c_{j0} + \sum_{s=1}^m c_j(s)CR(t-s) + \sum_{j=1}^4 \sum_{s=1}^m d_j(s)UN_j(t-s) + e'_j(t), \quad j = 1, \dots, 4. \quad (37)$$

where  $CR(\cdot)$  and  $UN(\cdot)$  are stationary time series of crime rate and unemployment rate, respectively;  $a(\cdot)$ ,  $b(\cdot)$ ,  $c(\cdot)$ , and  $d(\cdot)$  are autoregressive lag coefficients, and  $e(\cdot)$  and  $e'(\cdot)$  are white-noise error terms, being often called "innovations" in VAR studies, with no contemporaneous, as well as lagged, correlation with each other.<sup>10</sup>

In order to test the Granger-causality, i.e., tests of exogeneity, from  $UN_j$  to  $CR$  in the above VAR model, the null hypothesis is that the set of parameters  $b_j(s)$ ,  $s = 1, 2, \dots, m$ , should be zero if there is no Granger-causality from  $UN_j$ , i.e., the unemployment rate of the  $j$ -th group of people,

to CR.<sup>11</sup> On the other hand, if there is no Granger-causality from CR to  $UN_j$ , the set of parameters  $C_j(s)$  should be zero.

With respect to dynamic responses of CR to  $UN_j$ , the estimated autoregressive lag coefficients, i.e.,  $b_j(s)$ ,  $s = 1, \dots, m$ , in equation (36) include complicated cross-equation feedbacks and, hence, summing the estimated lag coefficients is quite misleading. Instead, after estimating the VAR model with appropriate lag distributions, the VAR model is inverted to a linear combination of the moving average process(MAR), which is defined as follows:

$$Z(t) = \sum_{s=0}^{\infty} R(s)E(t-s) \quad (38)$$

where  $Z(\cdot)$  is a vector of the variables in the model;  $R(\cdot)$  is a vector of MAR coefficients, and  $E(\cdot)$  is a vector of the innovations in the crime and unemployment rates, defined as  $E(t) = Z(t) - \hat{Z}(t)$  where  $\hat{Z}(t)$  represents the best linear forecast of  $Z(t)$  based on its past series  $Z(t-s)$ ,  $s > 0$ .<sup>12</sup> For example, in a particular equation of  $Z(t)$ , e.g., a murder rate(MURD) equation, the sum of MAR coefficients from  $s=0$  to  $s=k$  on the innovation in unemployment rate of the  $j$ -th group of people( $UN_j$ ) represents the cumulative responses of MURD in the  $k + 1$  step-ahead to random shocks in  $UN_j$ .

### III-2 Empirical Results

By using quarterly data for the United States, the behavior of seven different crime rates is analyzed over the period from the first quarter of 1970 through the fourth quarter of 1983: murder(MURD), rape(RAPE), robbery(ROBB), aggravated assault(ASSA), burglary(BURG), larceny-theft(LARC), and motor vehicle theft(AUTO)<sup>13</sup>. The unemployment rate variable gives male civilian unemployment rates for those sixteen to seventeen years old(U1617), eighteen to nineteen years old(U1819), twenty to twenty-four(U2024), and twenty-five years old and over(U25).<sup>14</sup> The system in our VAR model consists of four unemployment rates and two crime rates(the crime

rate in question and another related crime rate)<sup>15</sup> variables, all of which are expressed in logarithms.<sup>16</sup> The lag length in the variables is assumed to be the same in the VAR model and the results with four lag distributions are reported in this study. The Granger-causality tests are performed to examine if the unemployment rate variable has the explanatory power to predict the behavior of the crime rate dependent variable and vice versa.

Table I presents the F-statistics on the four lag coefficients of the unemployment rate variables: U25, U2024, U1819, and U1617. The results indicate that the effects of the male civilian unemployment rate for those twenty-five years old and over(U25) are pronounced and statistically significant in explaining the crime rates of murder, robbery, aggravated assault, burglary and motor vehicle theft.

Although it is widely believed that crime is committed largely by young people and many crimes by the same persons, our results for the male civilian unemployment rates among youths, e.g., those eighteen to nineteen years old(U1819) and those sixteen to seventeen years old(U1617), are statistically very weak. We find only LARK and AUTO for U1819 and MURD and LARC for U1617 to be significant.

According to the distribution of male arrests in 1984 in Uniform Crime Reports 1984(United States 1985, pp.174-175), males sixteen to seventeen years old accounted for 8.8 percent of all male arrests for violent crimes and 14.1 percent of those for property crimes in 1984. Males eighteen to nineteen years old accounted for 10.2 percent and 12.3 percent of all male arrests for the violent and property crimes in 1984, respectively. By contrast, males twenty five years old and over accounted for 48.7 percent and 32.5 percent of all male arrests for the violent and property crimes in the same year, respectively. Therefore, our dominant results for U25 may not be so unreasonable.

Table II reports the total impact of the unemployment rate for those twenty-five years old and over(U25) on the crime rates for the different months(6, 12, 18) ahead. We find that the impact of U25 on all crime rates is unambiguously positive at all time horizons shown. The exclusive positive association strongly supports the position that an increase in the

unemployment rate among the prime-age males (twenty-five years old and over) will necessarily raise the overall crime rate in the society.

In interpreting the numerical results of the cumulative responses in Table II, for example, the values under MURD indicate that an unexpected rise in U25 by one percent raises MURD by 1.32 percent in 6 months ahead, 2.12 percent in 12 months ahead and 2.28 percent in 18 months ahead. The other numerical values of each crime rate for the corresponding months ahead can be read in a similar manner.

Table III presents the summary of the F-statistics on the four lag coefficients of the crime rate variables in explaining the unemployment rate behaviors. It is quite noteworthy that no crime rates are statistically significant in explaining the movements in the unemployment rates.<sup>17</sup> From this result with the ones reported in Table I and II, we conclude the unemployment rate to be statistically exogenous to the crime rates, but not vice versa. The definite spillover effects, therefore, exist unidirectionally from unemployment to crime.

#### IV. Conclusion.

In this study, we have examined the interactions between the legal and illegal activities, and the relationship between the unemployment and the crime rates. The solution of the proposed model characterizes the personal traits of the criminals by highly risk-loving attitudes, and by the strong preference for leisure. Considering the distribution of the parameters representing each individual's attitudes toward risks and preferences for leisure, we have shown how labor would be allocated between the legal (employed or unemployed) and illegal (committing crimes) activities, and how this allocation would be affected by the changes in the market wage rate of the employed. From our theory, we derived the positive relationship between the unemployment and the crime rates, and the concurrent counter-cyclical movements of these two rates, which are found to be consistent with the given aggregate data.

In the empirical specification, we used a vector autoregressive model, and analyzed the behavior of the rates of seven different crimes - murder,

rape, robbery, aggravated assault, burglary, larceny-theft, and motor vehicle theft - over the period from the first quarter of 1970 through the fourth quarter of 1983. We have shown that the unemployment rate is statistically exogenous to the crime rate, so that, behind the positive relationships between these two rates, there lie economic forces and motivations directing the interactions between the two rates. In our view, this result strongly supports the necessity of the economic studies on the criminal behaviors.



### Footnotes

- (1) Some of the deterrent effects are due to changes in the probabilities of arrest, of conviction, and of punishment, and also the changes in the severity of punishment.
- (2) The cross-sectional static analyses are assumed to be based on a sample in long run equilibrium and consequently provide no information on the unemployment rate's lagged effects on the crime rate. A recent study by Corman, et.al.(1987) explicitly focuses the lagged effects on property-related crimes for New York City from 1970 to 1984.
- (3) A vector autoregressive model should be considered not a substitute for the estimation of structural models but an econometric method of clarifying the relevance as well as causal relationships among variables in the models.
- (4) See Uniform Crime Reports 1989(United States 1990), pp. 7-37, for the definitions of these crimes.
- (5) From 1980 to 1983, the notable rate reductions were among murder(a 19 percent reduction), robbery(a 14 percent reduction), burglary(a 21 percent reduction), and motor vehicle theft(a 14 percent reduction), based on the annual crime rates per 100,000 inhabitants(Uniform Crime Reports 1983, p.43).
- (6) For this formulation, see, for example, Gang and Gangopadhy 1987.
- (7)  $>$  and  $<$  in this study will mean  $\geq$  and  $\leq$ , respectively.
- (8) Recall that  $\hat{W}_1(\phi_v) > \hat{W}_3(R_1)$  for all  $R_1 \in [R_v, R_u]$ .
- (9) We assume  $|\partial S^j / \partial W^j| > |\partial S^i / \partial W^j|$ ,  $i \neq j$ ,  $i, j = 1, 2$ .
- (10) In equation (36), in addition to CR(t-s),  $s > 0$ , another related crime rate is included to take account, to some extent, of the effects of changes in legal sanctions and enforcement against illegal activities and also the effects of changes in other socioeconomic factors. Variables such as police number, arrest rate, and median income are instead recommended in the equation. However, the limitations in availability of quarterly data for such variables, and the cost of losing a large number of degrees of freedom have us choose the above specification.

(11) The Granger-causality test might be sensitive to misspecification, e.g., omitted variables or lag structure in the system. As mentioned earlier, it is very costly in terms of losing the degrees of freedom to include more variables and/or more lags in the system when only a small number of time series observations are available to test the Granger-causality.

(12) If the components of E are contemporaneously correlated, it is not possible to partition the variance of Z into pieces accounted for by each innovation. An orthogonalization for E is, therefore, made after a triangularization of the system. See Gordon and King(1982), p.213, for detail.

(13) These data are relative crime rates obtained from Crime in the United States: Uniform Crime Reports 1979, pp. 325-337; Uniform Crime Reports 1980, pp.351-369; Uniform Crime Reports 1981, pp.320-338; Uniform Crime Reports 1983, pp. 7, 14, 17, 22, 15, 29, 34, and 43. The relative crime rates in the first quarter of 1972 are normalized to 100 as a base period. Four observations for each of the seven crime rates in 1969 are estimated by using the corresponding quarterly data from 1970 to 1980. The observations from the first quarter of 1982 to the fourth quarter of 1983 are calculated based on the probability distributions of the six crime rates, reported in Uniform Crime Reports 1983.

(14) The quarterly data for the unemployment rates are provided by New York Office of U.S. Department of Labor, 201 Varick Street, New York, New York 10014.

(15) Because of a lack of theoretical justification for the choice of another related crime rate, a VAR model including all the seven crime rates variables without the unemployment-rate variables, is estimated to find one of the most significant variables to explain the behavior of the crime rate in question. In general, the burglary rate variable is used as another related crime rate.

(16) Each equation in the VAR model includes a constant term, a linear time trend, three quarterly dummy variables, and two other dummy variables such as  $D1 = 1$  for 1974(I)-1980(IV) and  $D1 = 0$  otherwise and  $D2 = 1$  for 1981(I)-1983(IV) and  $D2 = 0$  otherwise.

(17) The empirically observed positive relationship between the unemployment rate and the crime rate might be due to the other sociological factors such as premarket discrimination against the criminals, which are beyond the coverage of the present study. Statistical exogeneity of the unemployment rate, however, implies that the economic factors are very important in explaining the observed positive relationship, and we emphasize the statistical exogeneity in this respect.

## References.

- Allison, John P. "Economic Factors and the Rate of Crime" Land Economics May 1972, 193-96.
- Bechdolt, Burley V., Jr. "Cross-sectional Analyses of Socio-economic Determinants of Urban Crime" Review of Social Economy, October 1975, 132-40.
- Becker, Gary S. "Crime and Punishment: An Economic Approach" Journal of Political Economy, March/April 1968, 169-217.
- Corman, Hope; Joyce, Theodore, and Lovitch, Norman. "Crime, Deterrence and the Business Cycle in New York City: A VAR Approach" Review of Economics and Statistics, November 1987, 695-700.
- Danziger, Sheldon and Wheeler, David. "The Economics of Crime: Punishment or Income Redistribution" Review of Social Economy, October 1975, 113-31.
- Ehrich, Issac. "Participation in Illegitimate Activities: A Theoretical and Empirical Investigation" Journal of Political Economy, May/June 1973, 521-65.
- \_\_\_\_\_, "The deterrent Effect of Capital Punishment: A Question of Life and Death" American Economic Review, June 1975, 397-417.
- Fleisher, Belton M. "The Effect of Unemployment on Juvenile Delinquency" Journal of Political Economy, December 1963, 543-55.
- \_\_\_\_\_, "The Effect of Income on Delinquency" American Economic Review March 1966, 118-37.
- Gang, I.N. and Gangopadhy, S "Optimal Policies in a Dual Economy with Open Unemployment and Surplus Labor, Oxford Economic Papers 39, 1987, 378-87.
- Gordon, Robert J and King, Stephen R. "The output Cost of Disinflation in Traditional and Vector Autoregressive Models" Brookings Papers on

- Economic Activity, No.1, 1982, 205-42.
- Granger, C.W.J. "Investigating Causal Relations by Econometric Models and Cross-Spectral Methods" Econometrica, July 1969, 424-38.
- Heineke, J.M. "Economic Models of Criminal Behavior: An Overview" in Economic Models of Criminal Behavior, edited by J.M. Heineke. Amsterdam: North-Holland Publ., 1978, 1-33.
- Hoch, Irving. "Factors in Urban Crime" Journal of Urban Economics, April 1974, 184-229.
- Hoernack, Stephen A., and Weiler, William C. "A Structural Model of Murder Behavior and the Criminal Justice System" American Economic Review, June 1980, 327-41.
- Land, Kenneth C., and Felson, Marcus. "A General Framework for Building Dynamic Macro Social Indicator Models: Including an Analysis of Changes in Crime Rates and Police Expenditures" American Journal of Sociology, November 1976, 565-604.
- Myers, Samuel L., Jr. "Estimating the Economic Model of Crime: Employment versus Punishment Effect" Quarterly Journal of Economics, February 1983, 157-66.
- Pogue, Thomas F. "Effect of Police Expenditures on Crime Rates: Some Evidence" Public Finance Quarterly, January 1975, 14-44.
- Schmidt, Peter and Witte, Ann D, An Economic Analysis of Crime and Justice Orlando: Academic Press, 1984.
- Sims, Christopher A. "Macroeconomics and Reality" Econometrica, January 1980 1-48.
- Sjoquist, David Lawrence. "Property Crime and Economic Behavior: Some Empirical Results" American Economic Review, June 1973, 439-46.
- Spence, M. "Job Market Signalling" Quarterly Journal of Economics, Aug. 1973, 87, 355-79.
- Stiglitz, J.E. "Screening, Education, and Income" American Economic

Review, 1975, 65, 283-300.

United States. Department of Labor. Current Population Survey(CPS)  
in Microfiche. New York Office, 201 Varick Street, New York,  
New York 10014.

\_\_\_\_\_, Department of Justice, Federal Bureau of Investigation.

Crime in the United States: Uniform Crime Reports, 1979-1984,  
1988 and 1989. Washington: U.T. Government Printing Office, 1980-1985.  
1989 and 1990.

Weicher, John C. "The Effect of Income on Delinquency: Comment"  
American Economic Review, March 1970, 249-56.

Witte, Ann Dryden. "Estimating the Economic Model of Crime with Individual  
Data" Quarterly Journal of Economics, February 1980, 57-84.

Wolphin, Kenneth I. "An Economic Analysis of Crime and Punishment in  
England and Wales, 1894-1967" Journal of Political Economy, October  
1978, 815-40.

\_\_\_\_\_, "A Time Series-Cross Section Analysis of International Variation in  
Crime and Punishment" Review of Economics and Statistics, August 1980,  
417-23.

FIGURE 1

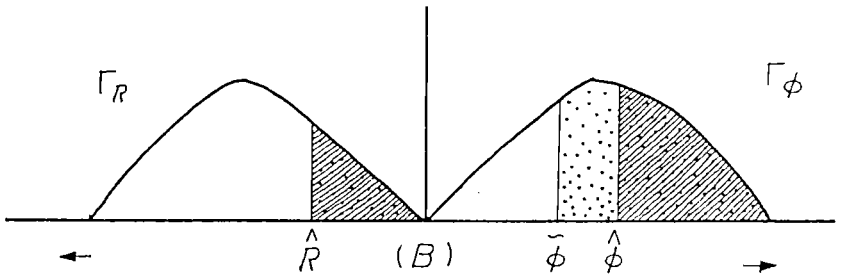
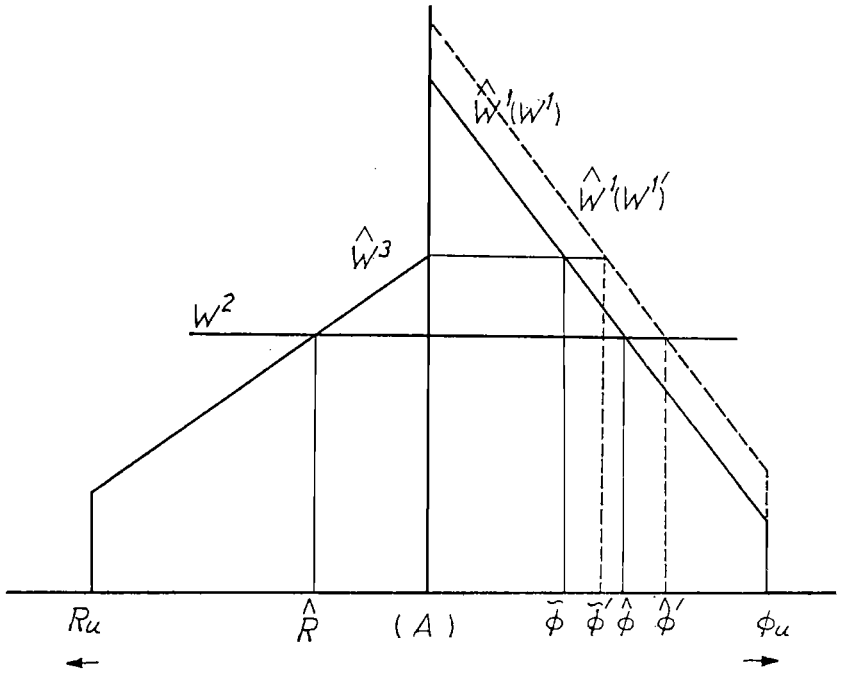


Table I  
 Granger-Causality Test  
 F-Statistics on Male Civilian Unemployment Rate\*  
 1970(I) - 1983(IV)

Independent variable	Dependent Variable						
	MURD	RAPE	ROBB	ASSA	BURG	LARC	AUTO
U25	2.593 <sup>c</sup>	2.558 <sup>c</sup>	6.330 <sup>a</sup>	5.653 <sup>a</sup>	3.153 <sup>b</sup>	.474	6.519 <sup>a</sup>
U2024	1.909	.633	3.973 <sup>b</sup>	2.202	1.410	1.930	1.418
U1819	.652	.842	.647	1.179	.406	2.327 <sup>c</sup>	2.833 <sup>b</sup>
U1617	2.668 <sup>c</sup>	1.100	.302	.655	.620	4.236 <sup>a</sup>	.312

\* the degrees of freedom = (4,25)

a. Significant at  $\alpha = 1\%$

b. Significant at  $\alpha = 5\%$

c. Significant at  $\alpha = 10\%$



Table II

Cumulative Responses of Crime to an Initial Shock in Innovation in  
Male Civilian Unemployment Rate for those 25 Years Old and Over

Months Ahead	Dependent Variable						
	MURD	RAPE	ROBB	ASSA	BURG	LARC	AUTO
6	1.32	1.00	1.33	.83	.75	1.50	.83
12	2.12	1.20	1.98	.78	1.63	1.23	.83
18	2.28	1.75	2.00	.58	2.25	2.88	.02

Table III

Granger-Causality Test  
 A Summary of F-Statistics on Crime Rates\*  
 1970(I) - 1983(IV)

CAUSAL VARIABLE	Effect Variable			
	U25	U2024	U1819	U1617
MURD	.584	.103	1.200	.378
RAPE	.391	.637	1.505	.085
ROBB	1.806	.729	.429	.936
ASSA	.750	.353	1.706	.017
BURG	.895	1.360	1.063	1.293
LARC	1.170	1.594	.447	1.471
AUTO	1.043	1.093	1.993	1.084

\* the degrees of freedom = (4,25)