UNEMPLOYMENT, GDP, AND CRIME RATE: THE SHORT- AND LONG-RUN RELATIONSHIP FOR THE AUSTRALIAN CASE

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Abstract:

Some categories of crime are found to have a long-run relationship with GDP and unemployment. The impulse response analysis of the cointegrated system between crime categories, GDP, and unemployment reveals the response from a shock in the unemployment rate is non-significant for any crime category, while a shock in GDP produces a small positive response in the number of charges and convictions for some criminal offenses.
1. Introduction

The link between economic conditions and crime has been the subject of considerable research. In a micro-economic context, the research has concentrated on modelling criminal behaviour from an expected utility perspective. The seminal work of Becker (1968) introduced an economic model which analysed the criminal choice decision in terms of the expected utility derived from participation in legal and illegal activities. Extensions of this model were introduced by several authors including Ehrlich (1973), Block and Lind (1975), Block and Heineke (1975). In a macro-economic context, the interest has focused more on the relationship between the business cycle and crime, see for instance Cook and Zarkin (1985). A sociological viewpoint is offered by Devine, Sheley, and Smith (1988).

This paper concentrates on the relationship between several categories of crime and the business cycle represented by GDP and the unemployment rate. The analysis combines both the short- and long-run dynamics of the relationship in a single dynamic model. For those categories of crime that show a long-run relationship to GDP and unemployment, an error correction model (ECM) is estimated and the corresponding impulse response analysis is presented. Our results indicate that for the period analysed, offences against persons, property and good order (defined shortly) hold a long-run relationship with GDP and the unemployment rate.

This paper is organised as follows: The categories of crime used in the study and the macro-economic model are introduced in Section 2. Section 3 explains the methodology employed in the analysis. Section 4 presents the results and Section 5 the conclusions.

2. Crime and the Macroeconomy

2.1. Criminal Statistics

Australia has somewhat of a chequered history regarding criminal statistics. The need for uniform crime statistics that are comparable by offence category between states and overtime has long been acknowledged. The main problems, common to federal systems in which the criminal law and law enforcement are state responsibilities, are differences in the definitions of offences and differences in the procedures used for collecting and classifying offences. In addition, changes in definitions and classifications over time within any given jurisdiction - a problem with all criminal statistics - makes time-series comparisons extremely difficult. In Australia a review of offence categories and classifications,
implemented in the early 1970s (and revised in 1977), led to irreconcilable discontinuation in the country's criminal statistics, which restricted the potential sample for this study to the years before 1971 (71 years). This is undoubtedly a major shortcoming of this study since it is possible that the relationship between crime and economic cycles (recessions and prosperity) has changed after 1971. However, the considerable amount of statistical compilation carried out by the Australian Institute of Criminology has provided a reasonably comprehensive range of data including police, judicial, demographic and death statistics. The data were collected in the Source Book of Criminal and Social Statistics (Mukherjee, Jacobsen and Walker, 1981) - hereafter, Source Book.

Given the difficulties of utilising large data sets for, in particular, fairly disaggregated offence categories, four broad classes are utilised in this analysis. These are: Total offences, Offences Against the Person, Offences Against Property and Offences Against Good Order. These series are defined by The Source Book of Criminal and Social Statistics, Australian Institute of Criminology pp. 228-229, as:

**Total Offences (TO)** - The sum of Offences Against the Person, Offences Against Property, Offences Against Good Order and Petty Offences.

**Offences Against the Person (PER)** - includes murder and attempt; manslaughter by driving; infanticide; abortion; kidnapping and abduction; rape and attempt; carnal knowledge; incest; bigamy; bestiality; sexual assault; indecent assault; aggravated major assault; inflicting grievous bodily harm; stabbing; shooting or wounding; common/minor assault; dangerous driving causing injury; administering poison.

**Offences Against Property (PRO)** - includes break, enter and steal; larceny or illegal use of vehicle or boat; stealing from the person; horse cattle and sheep stealing; malicious/wilful damage; embezzlement (including larceny by a clerk or servant); false pretences; fraudulent misappropriation; receiving; unlawful possession of property; arson; robbery.

**Offences Against Good Order (GO)** - drunkenness; drunk and disorderly; incident, riotous or offensive behaviour; vagrancy; offensive, threatening or abusive language; evading fare on a public vehicle; public mischief escape from custody; conduct scandalous or lewd; hindering/resisting arrest.

These offences are recorded at Magistrates' Courts. The crimes for each offence category are reported as "charges, convictions, discharges (includes acquittals, dismissals, withdrawals, and remands) and committals to higher court for trial." Any empirical analysis of the determinants of crime desirably utilises a measure of true offence rates. These are generally not available, and the researcher is forced to rely at best on recorded offence rates (or "crimes known to the police"), perhaps incorporating into the model certain assumptions about the relationship between true and recorded rates. See, for example,
Carr-Hill and Stern (1973). Otherwise research must focus explicitly on the determinants of the recorded offence rate, estimating what are in effect reduced-form equations which incorporate the direct effects of exogenous influences on the ratio of offences recorded, and the indirect effects operating via the true offence rate.

Unfortunately, the limitations on data availability and the need for a long time series means that the recorded offences data are not available. The best that can be done is to use "charges". This measure, along with "convictions", is used in the following analysis. Figure 1 presents a diagram of the criminal data available.

**Figure 1. Criminal Data Availability**

<table>
<thead>
<tr>
<th>Offences Committed (Unknown)</th>
<th>↓</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crimes known to Police (Recorded from the mid 1960s)</td>
<td>↓</td>
</tr>
<tr>
<td>Charges (Series available from 1901 to 1971)</td>
<td>↓</td>
</tr>
<tr>
<td>Convictions (1901 - 1971)</td>
<td>↓</td>
</tr>
<tr>
<td>Dismissals</td>
<td>Convictions</td>
</tr>
<tr>
<td>Committals</td>
<td>stop</td>
</tr>
<tr>
<td>Penalty stop</td>
<td>←</td>
</tr>
</tbody>
</table>

Initially, almost all charges must be heard in Magistrates' Courts, about 3% of those "Charges" are committed to a higher court for trial. Given that both series Charges and Convictions were available since the beginning of the century (1901) to 1971, we compare the findings for each one of the offence categories.
2.2 The Economic Model

The simple model under study states that in a macroeconomic context, the number of criminal offences (O) is related to the overall rate of unemployment (U) and GDP.

\[ O = f(U, GDP) \]  \hspace{1cm} (1)

In a theoretical context, the influence of economic activity variables on crime has been examined by, amongst others, Ehrlich (1973) and Sjoquist (1973). Invariably, measures of unemployment rates, and one or more income measure are also utilised as independent variables in all econometric studies of crime, for example Avio and Clark (1976), Withers (1984). The theoretical arguments for inclusion are that the relative returns to legal work fall during economic downturns (high unemployment, low GDP), hence providing an increased incentive to generate income via illegal work, or to pursue illegal methods of generating utility. However, there are other factors which might complicate this simple relationship. First, high unemployment may be associated with closer and more effective supervision of (crime-prone) young people by their parents. Secondly, low GDP also reduces the expected gains from theft (there is less to steal), so some studies have focused on increased income disparities as causal influences (Sjoquist, 1973, Withers, 1984). The empirical evidence reflects this ambiguity. While the weight of evidence supports the incentives story, there remains some doubt about the direction of influence of the "economic" variables.

As explained in section 2.1, data problems mean that variable O is not observable. Using charges (C) and convictions (K) as alternative dependent variables means that the relationships being investigated are of the forms

\[ C = g(O; U, GDP) = \phi(U, GDP) \]  \hspace{1cm} (2)

\[ K = h(O; U, GDP) = \gamma(U, GDP) \]  \hspace{1cm} (3)

In other words, we are estimating reduced-form relationships whose interpretation is fairly complex. A positive measured coefficient on U, for example, could reflect a positive effect on O and a positive effect of O on C, which is not outweighed by any direct negative impact of U on C. (Some of these matters are further considered in section 5.)

3. The methodology
The variables in the economic system under study are Offence Category (measured by charges or convictions) GDP and the unemployment rate (U). They can be represented in vector autoregressive (VAR) form as:

\[ A(L) Z_t = \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \end{bmatrix} + \begin{bmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{bmatrix} \begin{bmatrix} O_t \\ \text{GDP}_t \\ U_t \end{bmatrix} = e_t \]

This is the basic VAR model for three variables and \( p \) lags, where \( e_1, ..., e_T \) are i.i.d. \( N(0, \Sigma) \), \( L \) is the lag operator, and the maximum lag in \( A(L) \) is \( p \). The error-correction form (or error correction model ECM) of this model has become its most common representation. The ECM expresses the short-run changes of the variables in the system as a function of their short-run dynamics (lagged changes) and the long-run dynamics (the error correction term):

\[ \Delta Z_t = \delta + \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_p \Delta Z_{t-p+1} - \Pi Z_{t-p} + e_t \]

where

\[ \Gamma_i = -(I_3 - A_1 - ... - A_i), \quad i = 1, ..., p-1, \]

and

\[ \Pi = I_3 - A_1 - ... - A_p, \]

where \( I_3 \) is an identity matrix of order 3, and \( \Pi \) is known as the impact matrix. In compact notation (2) reduces to:

\[ Z_o = \Gamma Z_{t-1} + \Pi Z_{t-p} + E \]

where \( Z_o \) is a \( k \times T \) matrix of observations on first differences of \( Z_t \), \( Z_1 \) contains the lagged differences, and \( Z_p \) is the \( p \)th lag of \( Z_t \). The ECM representation allows for the variables in the system to be cointegrated. There is cointegration when the rank of \( \Pi \) equals \( r \) (\( 0 < r < 3 \)). The ECM reduces to a VAR in differences (only short-run dynamics) if \( \text{rank}(\Pi) = 0 \). The variables in the system are stationary if \( \text{rank}(\Pi) = 3 \) (in which case estimating (5) does not offer any advantages over estimating (4)). When co-integration is present, \( \Pi \) can be written in its restricted form as the product of two matrices

\[ \Pi = \alpha \beta' \]
where $\alpha$ and $\beta$ are $k \times r$ matrices, $\beta$ is the cointegrating vector, $\alpha$ is the loading matrix, and $r$ is the number of cointegrating relations in $\beta'Z_I$.

Representing the system of economic variables through an ECM allows testing for cointegration by testing the hypothesis $H(r): \text{rank}(\Pi) = r$. Two tests for this hypothesis were proposed by Johansen (1988) and Johansen and Juselius (1990), and they are known as the Trace and the Maximal Eigenvalue statistics. If $0 < r < k$, the system can be estimated by a maximum likelihood procedure (known as the Johansen estimator of cointegrated systems).

The impulse response (or dynamic multiplier) analysis of vector autoregressive systems has been a common tool of applied macroeconomic research. However, when systems are cointegrated, the estimation involves a few extra steps. Impulse response analysis of cointegrated systems is extensively discussed by Lütkepohl and Reimers (1992), and Lütkepohl (1993), thus our explanation is very brief.

Following Lütkepohl and Reimers (1992) we denote the impulse response of variable $z_i$ to a unit shock in variable $z_k$, $n$ periods ago,

$$
\Phi_n = (\phi_{ik,n}) = \sum_{j=1}^{n} \Phi_{k-j} A_j \quad n = 1, 2, \ldots, 
$$

Where $\Phi_0 = I_k$ and $A_j = 0$ for $j > p$, ($k = 3$ in our case). The orthogonalised impulses are defined as

$$
\Theta_n = (\theta_{ik,n}) = \Phi_n P,
$$

where $P$ is the lower triangular Cholesky decomposition of $\Sigma$ (i.e. the variance-covariance matrix of $E$ in equation (6)), that is, $PP' = \Sigma$. These impulses can be thought of as transformed residuals of the form $w_t = P^{-1} e_t$ which have identity covariance matrix. Thus, a unit impulse response has size one standard deviation in this case. One of the important differences between impulse responses in cointegrated systems and their stationary counterparts is that for the former the effect of a shock in one of the variables will in general not die out in the long-run. That is, a one-time shock may shift the system to a new equilibrium (permanent effect). Standard errors for $\hat{\Theta}_n$ can be obtained following Lütkepohl and Reimers (1992) and Lütkepohl (1990).

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1. This restriction also provides some insight into the causality implications of cointegration whereby causality can come about through the cointegrating relations $\beta'Z_I$ or by conditioning on $\alpha$ such that a row of $\alpha$ equating zero essentially excludes "long-run causality" in the corresponding equation.

2. The estimator has been shown to outperform other estimators of cointegrated systems (See Gonzalo, 1994).
4. Empirical Results

The per capita number of charges and convictions for the four offences defined in Section 2.1 (i.e., TO, PER, PRO, and GO), GDP per capita, and the unemployment rate between 1901 and 1971 for Australia were individually tested for non-stationarity. All series were found to be integrated of order one, I(1). An error correction model as in equation (5) was fitted with each offence category for lags p=2 and p=3. Some residual correlations were detected for the two lags model (p=2), therefore the final estimation was a VAR(3), with error correction representation:

$$\Delta Z_t = \delta + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} - \Pi Z_{t-3} + e_t$$  \hspace{1cm} (9)

Table 1 shows the results of the cointegration tests (Trace and Maximal Eigenvalue Statistics, with critical values from Osterwald-Lenum (1992), Table 1).

The results indicate evidence for one cointegrating relationship between offences, unemployment rate and GDP at the 5% for the following offences: Charges and convictions for offences against property, and charges for offences against good order. At the 10% significance level we found evidence for cointegration in the cases of: Charges for offences against the person and convictions for offences against good order. The existence of a long-run relationship between these economic variables imply that changes in GDP and/or unemployment may have a permanent effect on charges and convictions for the particular offence. In all other cases, the results indicate that changes in GDP and/or unemployment only have a temporary effect on those categories of offences. The estimates of the cointegrating vectors (normalised by the offence category) are presented in Table 2.
Table 1. Results of Cointegration Tests - Johansen Maximum Likelihood Procedure

(68 observations from 1904 to 1971. Maximum lag in VAR = 3).

<table>
<thead>
<tr>
<th>Series</th>
<th>Eigenvalues in descending order</th>
<th>Trace</th>
<th>Critical Value</th>
<th>Max. Eigenvalue</th>
<th>Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Null Alternative</td>
<td></td>
<td></td>
<td>Null Alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>r = 0</td>
<td>r = 1</td>
<td>r = 2</td>
<td>r = 3</td>
<td>r = 0</td>
</tr>
</tbody>
</table>

* Significant at 10% (Critical values, Trace = 26.7850, Max Eig = 18.5980).

Table 2. Estimates of cointegrating relationship between offences, unemployment rate and GDP

<table>
<thead>
<tr>
<th>OFFENCE</th>
<th>( \beta' = (\text{GDP, U, O}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charges for Offences Against the Person</td>
<td>-0.406112  \quad 0.505894   \quad 1.00</td>
</tr>
<tr>
<td>Charges for Offences Against property</td>
<td>-2.101577  \quad -0.515873  \quad 1.00</td>
</tr>
<tr>
<td>Convictions for Offences Against property</td>
<td>-2.396482  \quad -0.458876  \quad 1.00</td>
</tr>
<tr>
<td>Charges for Offences Against good order</td>
<td>1.039292   \quad 0.496926   \quad 1.00</td>
</tr>
<tr>
<td>Convictions for Offences Against good order</td>
<td>1.163214   \quad 0.372337  \quad 1.00</td>
</tr>
</tbody>
</table>
The estimates show that in the long-run, charges for offences against the person increase with increases in the unemployment rate and decrease with increases in GDP. This is not however the case for property and good order offences. Charges and convictions for offences against property would decrease with increases in both the unemployment rate or per capita GDP; while charges and convictions against good order will both increase with increases in the unemployment rate or per capita GDP. Lütkepohl and Reimers (1992) argue that the interpretation of cointegration relations may be difficult or misleading in applied cases, and thus the virtue of impulse response analysis since impulse responses may give interesting insights into the short- and long-run relations among the variables.

Figures 2, 3 and 4 present the orthogonal impulse responses of "charges" and "convictions" for different offences to a one-time shock in the unemployment rate or GDP per capita. The system is assumed to start at equilibrium (the equilibrium is placed at the origin of the coordinate system). The confidence bounds are of size two standard errors (2*se) and they are depicted by the broken lines. Since the responses have been orthogonalised, a one-time shock in unemployment (GDP) has size one standard deviation, and it is considered permanent if the variable does not return to its previous equilibrium state. When impulse responses are orthogonalised, the order of the variables in the system is important since contemporaneous feedback is restricted to occur only from the left to right in the ordering. In our case the order was GDP, U, O. This ordering allows for GDP and U to have an instantaneous effect on crime, and assumes there is a lag between occurrence of crime and its effect on unemployment and GDP. In four cases the effect of a one-time shock appears permanent and significant, that is, the new equilibrium settles at a significantly different value from the initial state. These cases are GDP --> charges for PER, GDP --> charges for GO, GDP --> convictions for GO, and GDP --> convictions for PRO. For charges and convictions for good order (Figure 4), the responses to a GDP shock are slightly positive. A one-time shock in GDP has a significant positive permanent effect on the number of charges and convictions for offences against good order, and charges for offences against the person (Figure 2). However, the new equilibrium is only scarcely different from zero. Finally, for the case of convictions for offences against property, a

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3 The standard errors were computed from Proposition 1 Lütkepohl (1990).

4 Significantly different is taken to be when the confidence bound does not include zero (the initial equilibrium value).
GDP shock shows an initial negative response and a convergence to a level slightly positive. The shock does not have a permanent effect in the case of GDP \(\rightarrow\) charges for PRO. The initial response is negative, with the value returning to the zero origin. In all other cases (i.e., shocks in unemployment), the responses are insignificant with the confidence bound containing zero. These results indicate that the impact of changes in the unemployment rate on the number of charges or convictions is not permanent for the offences studied.

5. Conclusions

This paper has presented the results of a study into the dynamics of GDP, unemployment, and four offence categories. We found evidence of cointegration in five models: (1) Charges for offences against the person, GDP and the unemployment rate; (2) Charges for offences against property, GDP and the unemployment rate; (3) Convictions for offences against property, GDP and the unemployment rate; (4) Charges for offences against good order, GDP and the unemployment rate; and, (5) Convictions for offences against good order, GDP and the unemployment rate. The dynamics of these relationships were further analysed through an impulse response analysis. In general, charges and convictions' responses to increases in GDP or unemployment did not have a substantial effect on crime (charges and convictions) for the sample period under study, 1901-1971. Changes in GDP have a small positive effect on the number of convictions for offences against good order, offenses against the person, and the number of charges for offences against good order, the person, and the property. This positive value may signal the problem of measuring "crime" by "charges" and "convictions" instead of "number of crimes committed." During booming economic times, it is likely that more resources are available to the enforcement agencies, as well as a higher pressure from the community for a "crime free society." It is still unclear what type of relationship "crimes committed" have with "charges." Changes in the unemployment rate did not have a significant long-run effect on charges or convictions for any of the crime categories studied.

Structural changes in the relationship between crime, GDP, and the unemployment rate may have occurred after 1971, and thus our conclusions may not be entirely transferable to the situation of the 1980s and 1990s. However, the results seem to point at two important conclusions. The first is that some of the determinants of the business cycle (GDP) may have a long-run relationship with some categories of crime. The second (and perhaps more important message) is that the effect is relatively small. In other words, a large increase (decrease) in GDP is not likely to trigger a large
increase (decrease) in crime. And, a large increase (decrease) in unemployment is not likely to have a significant effect on crime.
Figure 2. Offences Against the Person
Figure 3. Offences Against the Property
Figure 4. Offences Against Good Order
6. References


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