Department of Economics
UNIVERSITY OF CANTERBURY
CHRISTCHURCH, NEW ZEALAND

ISSN 1171-0705

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Discussion Paper

No. 9817

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Christchurch, New Zealand

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December 1998

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Unemployment and Crime: New Answers to an Old Question

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November 1998

This paper uses panel data techniques to examine the relationship between unemployment and a range of categories of crime in New Zealand. The data cover sixteen regions over the period 1984 to 1996. Random and fixed effects models are used to investigate the possibility of a causal relationship between unemployment and crime. Hypothesis tests show that the inclusion of random region effects and fixed time effects produces the most efficient model. The main finding of the paper is that unemployment cannot explain changes in the overall crime rate, although significant effects on crime are found for some subcategories of crime.

We are grateful to Rachel Bambery, New Zealand Police National Headquarters, for her assistance in obtaining crime and population statistics. The staff of the University of Canterbury Library also gave invaluable help in unraveling the complexities of New Zealand unemployment and income data. The paper has benefited from useful comments by participants of the CEPR conference on "Metropolitan Economic Performance", Lisbon, October 1998.

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"He must be a bold man indeed who is confident that he knows what causes crime."
FELIX FRANKFURTER (?)

1. Introduction

It is a common observation for many countries that unemployment rates and crime rates tend to be positively associated. It is a more contentious issue whether this association means that unemployment causes crime, crime causes unemployment, or third factors cause both. Only the first of the three possibilities would imply that the effects of unemployment on crime deserve to be counted among the "non-pecuniary" costs of unemployment that should be taken into account by any cost-benefit analysis of potential unemployment-reducing policies.

The theoretical underpinning of the causality notion was developed some thirty years ago by Becker (1968), Stigler (1970) and Ehrlich (1973), among others. In Ehrlich's model individuals divide their time between legal activities and risky illegal activities. If legal income opportunities become scarce relative to potential gains from crime the model predicts that crime will become more frequent. Increased unemployment would be one such factor.

Numerous subsequent empirical papers have attempted to test the predictions of the Becker-Ehrlich model, and to find out whether the magnitude of the unemployment effect is quantitatively important. The hallmark of this literature is its failure to reach consensus as to whether higher levels of unemployment lead to a greater incidence of crime. In a survey of the literature, Box (1987) reports 35 reliable studies on the topic, 20 of which find a positive relationship between unemployment and crime, with the remainder unable to find any such relationship.

The objective of this paper is to revisit the issue of whether unemployment has a causal effect on various categories of economic and anti-social crime. For this purpose, we analyse New Zealand regional panel data, regressing crime rates on unemployment rates using fixed and random effects models. Our approach solves several of the problems that have been characteristic of previous empirical papers. In particular, we cannot reject the hypothesis that unobservable period specific effects are correlated with the unemployment rate. This finding suggests that time series regressions will likely be affected by omitted variable bias.

Indeed, a previous econometric study for New Zealand by Small and Lewis (1996), based on time-series techniques and Granger causality tests, lends "strong support to the idea that crime and unemployment are linked in some way" and that unemployment causes crime more often than *vice versa*. Our results, based on regional panel data, are much more cautious. By and large, we find no evidence for a causal relationship.

The paper is structured as follows. Section 2 commences with an eclectic review of some previous empirical studies. Section 3 gives a discussion of some general data issues as well as a description of the data that were actually used in this study. The results from the various models are presented in Section 4. Section 5 concludes with commentary on the implications of these findings and possible improvements that could be made to the analysis.

2. Previous Studies

As mentioned in the introduction, a consensus as to whether higher levels of unemployment lead to a greater incidence of crime has not yet been reached. Differences in the results may be related to a variety of factors: differences in the type of data used and differences in the definition of crime being two of them.

The empirical literature on the topic of crime and unemployment typically is based on one of four types of data: aggregate (national) time series data, aggregate cross-section data, regional panel data, or individual level data. Studies of the first two types often affirm the existence of a causal relationship. Ehrlich (1975), Leveson (1976), Chapman (1976) and Brenner (1978) are some early examples. While these studies to varying degrees attempt to control for other factors, they still are likely to be affected by omitted variable bias. The availability of regional panel data can ameliorate this problem, and indeed, when such data are used, the evidence is much less supportive of a causal relationship. For example, Entorf and Spengler (1998) found unemployment to have "small, often insignificant and ambiguous signs".

With individual level data one observes the labour market status of a particular offender at the time of committing a crime. Studies include Myers (1983), Schmidt and Witte (1984), Trumball (1989), Tauchen *et al.* (1994), and Grogger (1991). There are several advantages of such data: the number of observations is large, these datasets usually provide a large number of controls and it becomes possible to focus on particular sub-populations, such as the socially less advantaged, where an effect might be more likely to occur. Individual level data do not, however, solve the omitted variable problem as it is most likely that additional unobserved factors, such as "ability" or "character" affect both the propensity to commit a crime and the likelihood of unemployment. Hence, unless one has access to individual level panel data, one can argue that the use of regional panel data is the best methodological option.

An independent issue is the definition of crime, with the distinction between economic and anti-social crime. Economic crimes are those where the motivation is pecuniary gain, while anti-social crimes are committed for some other reason. Most economic studies have focused on the link between unemployment and economic crimes since such a relation is supported by economic theory, which predicts that potential offenders compare the costs and benefits associated with crime. Nevertheless, the notion that rises in unemployment lead to increases in anti-social crime has been proposed by sociologists and others. As a consequence, the total costs of unemployment may be higher than some studies predict.

Finally, the issue of whether reported crime accurately reflects the actual number of committed crimes arises. Using reported crime might be a misleading indicator of the total amount of crime in society as not all crimes committed are reported to the police. Hence, this measure is dependent on the public's proclivity to report crimes to the police. This would be of minor empirical importance unless the likelihood that crimes are reported has changed significantly over time. There is some evidence, however, that this was the case, providing a further argument in favour of the use of regional panel data as they are in general unaffected by this measurement issue.

3. Data

Annual data on the level of crime was obtained from the New Zealand Police for the period 1984-1996 for 16 police districts. This included the number of offences reported to police in each police district for a series of offence groups and the total number of crimes, which they collectively comprise. The groups used by the New Zealand Police are: violent offences; drug and anti-social offences; dishonesty offences; property damage offences; property abuse offences; sexual offences; administrative offences.[1] The number of crimes reported for each category was denoted by $O1$ to $O7$, respectively, with the total number represented by O. Numbers were transformed into crime rates, denoted o and $o1$-$o7$, by division with the regional population size (in thousands).

There are a variety of measures of unemployment in New Zealand. The official measure is the Household Labour Force Survey (HLFS), conducted quarterly by Statistics New Zealand. The HLFS provides estimates which are internationally comparable and are not subject to changes in the definition of "being unemployed". Unfortunately, the series only includes sub-national estimates

since 1990. The quinquennial Census of Population and Dwellings provides the most complete survey of unemployment in New Zealand. However, drawbacks are the infrequent observations provided and the fact that different definitions of unemployment have been used over time.

Because of these shortcomings, the measure of unemployment selected for this study was the number of people registered as unemployed with the Department of Labour, hereinafter denoted by *UN*.[2] Annual averages of this series were obtained for each of 21 employment districts for the same period from Statistics New Zealand's INFOS, and were then matched to the 16 police districts. Unemployment rates were obtained by division with a labour force estimate and were denoted by *un*.

As will be explained later in this paper, possible determinants of the crime level other than unemployment were also investigated in the study. Firstly, the clearance rate for each offence group was obtained from the New Zealand Police. This is given by the ratio of the number of crimes cleared by police to the total number of crimes reported for each region and crime sub-category. The overall clearance rate was denoted p while the clearance rates for each offence group were denoted $p1$-$p7$, where the index matches the crime sub-category number.

Secondly, information on the average level of income for each region was obtained. Since there is no annual sub-national data for income in New Zealand, information from the 1986, 1991 and 1996 Censuses on mean personal income for each police district was used. To obtain a complete panel, the income of each district relative to the national average was calculated, using simple regression on a time trend to calculate the missing observations. An annual index of real GDP per capita for *all* New Zealand was derived from the New Zealand National System of Accounts for 1984-1996, based on 1984 = 1000. The income series used in this study, denoted y, was the product of this series and the estimate of the relative income of each region for the appropriate year.

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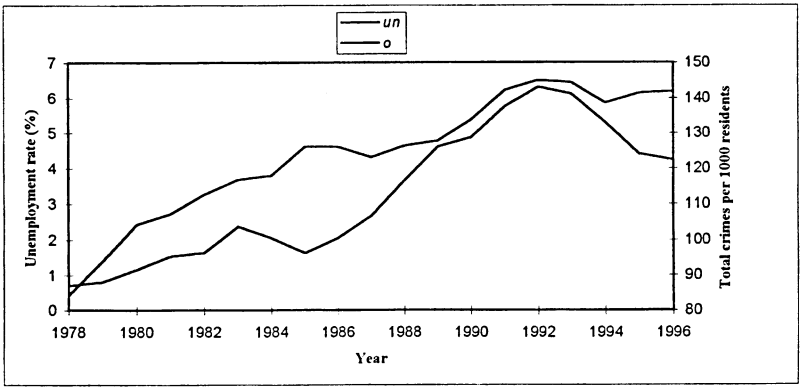
[1] The Appendix gives details of the composition of these sub-categories.

[2] This is also the series Small and Lewis (1996) used in their study on the subject. The registered unemployed are those people who have chosen, as one of their methods of job search, to enrol with the New Zealand Employment Service and who are available for employment.

4. Results and Analysis

Figure 1 plots the movement in national values of *un* and *o* between 1978 and 1996. There is visual evidence that the two move closely together over time. The correlation coefficient *r* was estimated to be 0.41. However, as mentioned in the introduction, this is by no means an indication of causality. Economic theory and overseas evidence point to the importance of third variables in determining the crime rate.

Figure 1
New Zealand Unemployment Rate and Crimes per 1000 Residents



Source: New Zealand Police (*o*), Statistics New Zealand (*un*)

Pooled regression

Following Entorf and Spengler (1998), a log-log specification of the unemployment-crime relation was used. This gives rise to an estimated coefficient that has the interpretation of an elasticity. A log-log model is also consistent with Ehrlich (1973), who suggested a multiplicative form for the supply-of-offences function when variables are in levels.

One extreme possibility is that unemployment is the sole determinant of the crime rate and that the parameters of the model are identical, regardless of what region or year an observation is drawn from. This implies that a pooled regression can be applied to the data as follows:

$$\ln o_{it} = \alpha + \beta \ln un_{it} + u_{it}$$

Here the subscript i indicates the region of the observation and t the year of the observation. u_{it} denotes the residual associated with observation i,t. All observations are treated the same in the model, regardless of the region or year from which they are taken. Table 1 reports the parameter estimates $\hat{\alpha}$ and $\hat{\beta}$ obtained from pooled regression of the logged total crime rate on the logged unemployment rate. $\hat{\beta}$ is positive and the corresponding t-statistic is shown to be significant at the 1% level. However, this inference neglects the question of how appropriate such a regression is, given the data used in this study.

Table 1
Results from Pooled Regression of ln*o* on ln*un*

Parameter:	Estimate: [a,b]
$\hat{\alpha}$	4.654 **
	(136.91)
$\hat{\beta}$	0.144 **
	(6.37)

[a] t-statistics are shown in brackets.
[b] * denotes significance at the 5% level; ** denotes significance at the 1% level.

Figures 2a and 2b help to address this question. Figure 2a is a scatter plot of the average crime rate over the sample period for each region, o_i, against the time-averaged unemployment rate, un_i. Figure 2b is a scatter plot of annual observations of the national value of the crime rate, o_t, against annual observations of the national value of the unemployment rate, un_t.[3] Together, the graphs reveal no strong relationship between o_i and un_i but indicate that o_t and un_t are positively correlated. This suggests that the model is incorrectly specified. Either there are region-specific factors present which inhibit the ability to report a positive relation in Figure 2a or there are time-specific factors which create the appearance of a link between unemployment and crime over time or a mixture of both situations exists.

[3] National observations can be considered weighted averages of the regional observations, thus giving convenient estimates of *o* and *un* that have a time dimension only.

Figure 2a
Scatter Plot of Time-Averaged Crime and Unemployment Rates

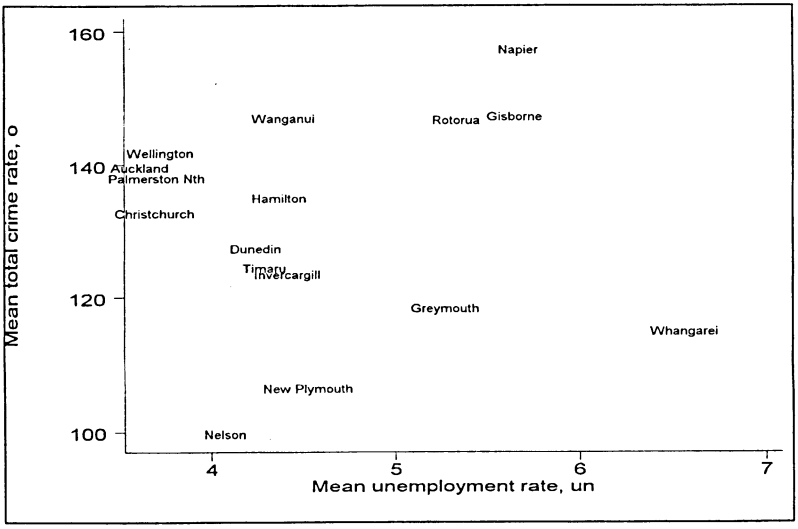


Figure 2b
Scatter Plot of Region-Averaged Crime and Unemployment Rates

If it is assumed that factors other than unemployment affect the value of the dependent variable $\ln o_{it}$, the pooled regression residual u_{it} can be considered as representing omitted variables peculiar to both the regions and years for which observations are obtained, variables reflecting individual differences that are time-invariant and variables that reflect factors peculiar to specific years that affect regions equally (Hsiao, 1986). As a consequence the error term can be expressed as the sum of three components:

$$u_{it} = \mu_i + \lambda_t + \varepsilon_{it}$$

Here u_{it} has been decomposed into a region-specific effect, μ_i, a time-specific effect, λ_t, and a white noise error term, ε_{it}, which is unique to each observation. A possible factor that might feature in μ_i is the degree of urbanisation. Figure 2a shows that major metropolitan centres like Auckland, Wellington and Christchurch tend to have low values of un_i and high values of o_i. It is quite possible that more densely populated regions offer more employment opportunities but also support higher levels of criminal activity. The age and ethnic structure of the various regions may also impact on μ_i.

The period specific effects λ_t capture, for instance, any change in macro-economic conditions, such as inflation or oil-price shocks, that might be expected to lead to higher levels of crime (assuming that they affect all regions equally). In addition, these effects account for changes in the propensity to report crimes over time. For instance, surveys conducted by Market Research Limited (M.R.L.) in 1993 and 1995 found that the proportion of victims who had reported the most recent crime to the police increased from 67% to 77% between these years.

A key requirement for consistent estimation of the pooled regression by ordinary least squares is that $\ln un_{it}$ is uncorrelated with u_{it}. This implies that $\ln un_{it}$ must be uncorrelated with both μ_i and λ_t. However, if the omitted variables in the model affect the independent variable as well as the dependent variable then this condition will not be met. As a result, the parameter estimates reported in Table 1 may not be valid and the conclusion that unemployment is a significant determinant of crime premature.

The two-way fixed effects model

To avoid omitted variable bias in the presence of correlation between the independent variable and the error components in the pooled regression, dummy variables can be introduced to condition

on the region-specific or time-specific effects. The two-way fixed effects model involves estimation of the following equation:

$$\ln o_{it} = \alpha + \mu_i + \lambda_t + \beta \ln un_{it} + \varepsilon_{it}$$

This is an identical specification to the pooling case, only that now μ_i and λ_t are considered to be parameters to be estimated, whereas before they were assumed to be white noise error terms. If all observations are collected together and ordered by region and year this can be expressed as:

$$\ln \mathbf{o} = \alpha + \bar{\mathbf{I}}_n \otimes \mathbf{i}_T \mu + \mathbf{i}_n \otimes \bar{\mathbf{I}}_T \lambda + \ln \mathbf{un} \beta + \boldsymbol{\varepsilon}$$

Here lno, lnun and ε are all ($nT \times 1$), μ is ($n \times 1$) and λ is ($T \times 1$), where n is the number of regions observed and T is the sample length in years.[4] $\mathbf{i}_T$ and $\mathbf{i}_n$ are T-dimensional and n-dimensional column vectors of ones, respectively. $\bar{\mathbf{I}}_T$ and $\bar{\mathbf{I}}_n$ are identity matrices of dimension T and n, respectively, with the first row set equal to zero in both cases.[5] ⊗ denotes the Kronecker product.

Table 2 reports the results of applying this model to the total crime rate and unemployment rate. Note that the estimated coefficient on ln*un*, $\hat{\beta}$, is now insignificant at the 5% level. By controlling for the influence of omitted variables that are either time-invariant or region-invariant, the evidence of a link between unemployment and crime disappears.

Table 2
Results from the Two-Way Fixed Effects Model

Parameter:	Estimate:
$\hat{\alpha}$	4.485 **
	(68.80)
$\hat{\beta}$	0.080
	(1.449)

The significance of the two types of fixed effects can be tested by a series of F-tests. There are three hypotheses of interest: one can test for the joint significance of both region and time

[4] In this study $n = 16$ and $T = 13$.

dummies, the existence of region effects given time effects or the existence of time effects given region effects (Baltagi, 1995). The general test statistic is given by:

$$F = \frac{(RSS_R - RSS_U)/j}{RSS_U/(nT-(n-1)-(T-1)-k)}$$

Here RSS_U and RSS_R denote the residual sum of squares from the fixed effects regression and the appropriate restricted model, respectively.[6] k is the number of regressors in the unrestricted model other than dummy variables, namely 2. j is the number of degrees of freedom gained by moving from the unrestricted model to the restricted model.[7]

Table 3
Testing the Fixed Effects

Null hypothesis:	F-statistic: [a]
H_0: $\mu = 0, \lambda = 0$	18.713 **
H_0': $\mu = 0$ given $\lambda \neq 0$	15.343 **
H_0'': $\lambda = 0$ given $\mu \neq 0$	2.743 **

[a] Critical values are, at the 1% level, 1.85 for H_0, 2.14 for H_0' and 2.29 for H_0'', respectively.

Since the first statistic listed is significant at the 1% level, the null hypothesis that region and time effects are jointly zero can be rejected. Hence, there is evidence against the simple pooled model. It is noted that the test statistics for the other two hypotheses are also significant at the 1% level. It can be concluded that crime rates are subject to significant period and region effects.

Improving the efficiency

Under the assumption of the model the fixed effects estimator is unbiased and consistent, whether or not the region and period effects are correlated with ln*un*. However, if either the time or the region effects (or both) are uncorrelated with the independent variable, ln*un*, then it is not the

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[5] $\bar{\mathbf{I}} = \begin{bmatrix} 0 & 0 & 0 & \cdots & 0 \\ 0 & 1 & 0 & & 0 \\ 0 & 0 & 1 & & 0 \\ \vdots & & & \ddots & \vdots \\ 0 & 0 & 0 & \cdots & 1 \end{bmatrix}$.

[6] The appropriate restricted model is pooled regression for the first hypothesis, regression with time dummies only for the second and regression with region dummies only for the third.

[7] j is equal to $n+T-2$ for the first hypothesis, $n-1$ for the second and $T-1$ for the third.

most efficient estimator. In this case a random effects estimator should be used. In essence, the decision is whether to make inferences conditional on the effects observed in the sample or unconditional (marginal) inferences with respect to the population characteristics.

The hypothesis of no correlation between either μ_i or λ_t and the independent variable can be written as $E(\mu_i|\ln un_{it}) = 0$ and $E(\lambda_t|\ln un_{it}) = 0$, that is, knowledge of un_{it} does not improve one's prediction of the effects. Since μ_i and λ_t represent unobservable factors, this cannot be determined, although the estimates obtained from the fixed effects regression, $\hat{\mu}_i$ and $\hat{\lambda}_t$, can be used to draw some inference. Figures 3a and 3b plot time-averaged unemployment, $\ln un_i$, against $\hat{\mu}_i$ and region-averaged unemployment, $\ln un_t$, against $\hat{\lambda}_t$. While there is no clear link between $\ln un_i$ and $\hat{\mu}_i$, $\ln un_t$ and $\hat{\lambda}_t$ exhibit a weak positive relationship. It appears possible that $E(\lambda_t|\ln un_{it}) \neq 0$, that is, there is correlation between the unemployment rate and the time effects.

Figure 3a
Scatter Plot of Time-Averaged Unemployment Rate and Estimated Region Effects

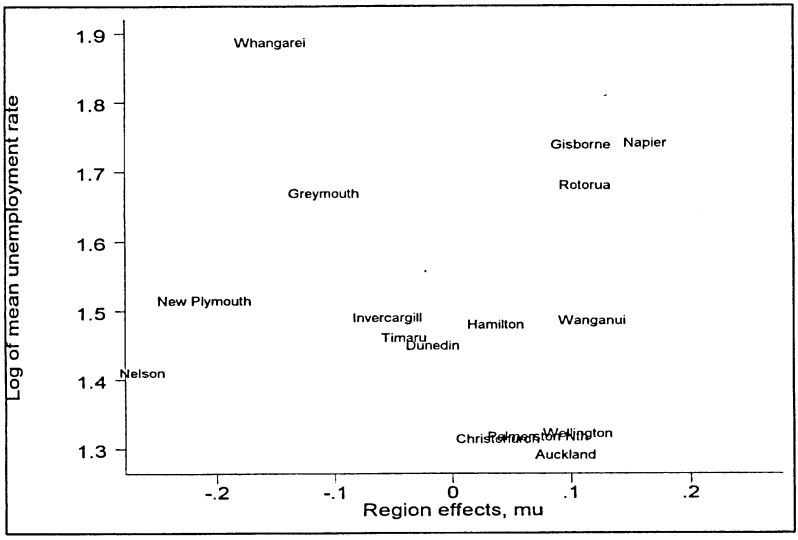
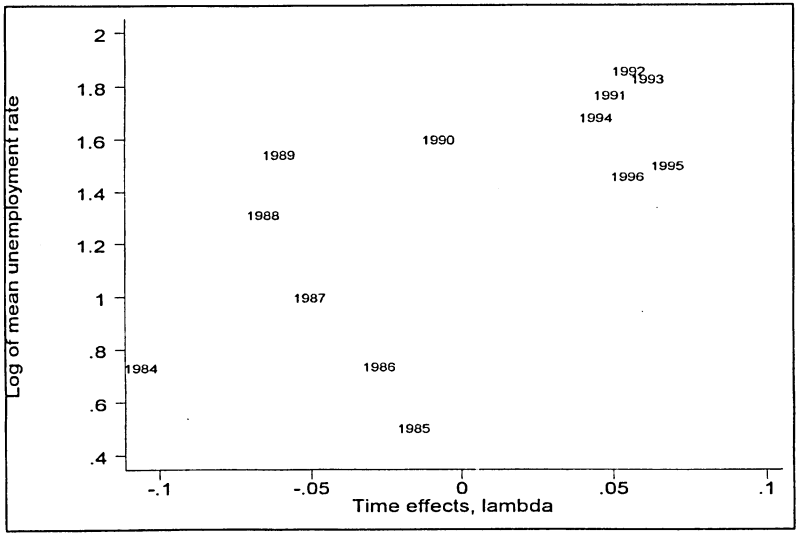


Figure 3b
Scatter Plot of Region-Averaged Unemployment Rate and Estimated Time Effects



In order to test this contention, one can attempt to "explain" the fixed effects from the estimated model by regressing them on the appropriately averaged unemployment rate, as follows:

$$\hat{\lambda}_t = \theta_0 + \theta_1 \ln un_t + \varepsilon_t$$
$$\hat{\mu}_i = \theta_0 + \theta_1 \ln un_i + \varepsilon_i$$

A significant value of θ_1 can be interpreted as evidence that there is correlation between the unemployment rate and the particular effect in question. Table 4 presents the results of a series of such auxiliary regressions, where estimates of the effects were obtained both from the two-way fixed effects model discussed earlier and from one-way fixed effects specifications.[8] It is noted that the *t*-statistics for θ_1 are significant only when the time effects are used as the dependent variable. This would seem to confirm the observation made from inspection of Figure 3 that the unemployment rate is correlated with time effects but not region effects. A fixed time effects specification with random region effects would therefore seem to be the most efficient option for estimation of the crime-unemployment relation.

Table 4
Results from the Auxiliary Regressions

Dependent variable:	$\hat{\theta}_0$	$\hat{\theta}_1$
$\hat{\mu}_i$ (one-way)	0.2229	-0.1477
	(0.769)	(-0.774)
$\hat{\mu}_i$ (two-way)	0.0963	-0.0638
	(0.332)	(-0.334)
$\hat{\lambda}_t$ (one-way)	-0.1657 **	0.1245 **
	(-3.983)	(4.195)
$\hat{\lambda}_t$ (two-way)	-0.1119 *	0.0841 *
	(-2.714)	(2.858)

The random region, fixed time effects model

Table 5 reports the estimates of α and β obtained when the random region, fixed time effects model was applied to ln*o* and ln*un*. The table also includes the parameter estimates which result from using the crime rate for each offence group as a dependent variable. The results largely confirm the conclusion from the two-way model that the unemployment rate has no significant effect on the rate of crime. However, the unemployment rate *does* have a significant effect on crime in two of the six offence groups. A 1% increase in the unemployment rate leads to a 0.22%

[8] I.e. models that include *either* time effects or region effects.

increase in the number of drug and anti-social offences reported and a 0.28% rise in the number of property abuse offences reported.

Therefore, after purging the unique influence each year has on crime, unemployment can account for little of the variation in the crime rate, including dishonesty offences, which Small and Lewis (1996) believed were partly determined by unemployment.

Table 5
Results from the Random Region, Fixed Time Effects Model

Dependent variable:	$\hat{\alpha}$	$\hat{\beta}$
ln*o*	4.642 **	0.0755
	(86.359)	(1.429)
ln*o*1	1.644 **	0.1029
	(21.53)	(1.306)
ln*o*2	2.588 **	0.2162 *
	(27.40)	(2.154)
ln*o*3	4.249 **	0.0269
	(65.60)	(0.500)
ln*o*4	2.096 **	0.0547
	(25.83)	(0.683)
ln*o*5	1.543 **	0.2808 **
	(14.992)	(2.583)
ln*o*6	-0.1040	-0.0721
	(-0.998)	(-0.618)

These results can be used in Hausman's (1978) specification test to provide further evidence on the relative efficiency of random and fixed effects models. This test involves comparing the parameters estimated using both random and fixed effects specifications. Under the null hypothesis that the independent variable is uncorrelated with the error term the coefficients estimated by either model are consistent but random effects is efficient. However, if the null hypothesis is false, the use of random effects produces an inconsistent estimator. The fixed effects estimator is consistent in this case and would be preferred.

Two testable hypotheses were used for the Hausman test on the two-way model. Both were based on the following test statistic, which is asymptotically distributed as $\chi^2(1)$ under the null hypothesis:[9]

[9] There is one degree of freedom as only the coefficients β are being tested; the time and region effects are orthogonal by definition.

$$m = \frac{(\hat{\beta}_{\kappa} - \hat{\beta}_{\pi})^2}{\text{var}(\hat{\beta}_{\kappa} - \hat{\beta}_{\pi})}$$

Here $\hat{\beta}_{\kappa}$ and $\hat{\beta}_{\pi}$ are the coefficients on $\ln un$ obtained from estimation of the two-way fixed effects model and a mixed effects model, respectively. It can be assumed that μ_i are fixed and $E(\lambda_t|\ln un_{it}) = 0$ can be tested by estimating the fixed region, random time effects model and obtaining m_{λ}. In addition, it can be assumed that λ_t are fixed and $E(\mu_i|\ln un_{it}) = 0$ can be tested by estimating the random region, fixed time effects model and obtaining m_{μ}.

The following estimates were calculated: $m_{\lambda} = 3.459$ and $m_{\mu} = 0.068$. At the 10% level the first statistic is significant, but the second is not.[10] Therefore more evidence has been generated in favour of the mixed effects specification, where period effects are treated as fixed and region effects are treated as random, over the two-way fixed effects specification.

The augmented model

The Becker-Ehrlich specification suggests that the deterrence rate and level of income are the primary factors influencing a rational individual's decision whether to commit crime. As described in Section 3, suitable proxy variables for both of these factors were obtained, namely the clearance rate, p, and the level of income, y. It is possible that a significant link does exist between unemployment and crime, but that the omission of the other variables has led to this relationship being clouded over to an extent that estimation yields insignificant coefficients on $\ln un$. These variables should then be included as regressors in the model along with the unemployment rate in a multiple regression framework.

It is generally hypothesised that the deterrence rate has a negative effect on the crime rate. As the likelihood of potential criminals being caught increases, the expected penalty resulting from crime increases.[11] This decreases the probability that a rational agent will choose to commit an offence.

The expected relation between o and y is less clear cut. Increases in income can be thought of as reflecting an increase in the benefits derived from legal activities, thus a negative relation may be posited. However, as income increases the potential gains from economic crimes may also

[10] The 10% critical value is $\chi^2(1) = 2.706$.

[11] The expected penalty is given by the probability of capture and conviction times the severity of the sentence imposed. Buchanan and Hartley (1996) note that in New Zealand although the severity of prison sentences remained roughly constant for part of the period 1983-1992 the "penalty probability" fell due to decreases in the conviction rate over this period.

increase. This would improve the attractiveness of crime relative to legal work and a positive relation between o and y may be observed. Which effect will dominate is unclear. Entorf and Spengler (1998) believe that the unemployment rate could be interpreted as a measure of legal income opportunities, while the absolute level of income represented illegal income opportunities.[12]

Table 6 reports the results of two-way fixed effects estimation of the following model:

$$\ln oj_{it} = \alpha + \mu_i + \lambda_t + \beta \ln un_{it} + \gamma \ln pj_{it} + \delta \ln y_{it} + \varepsilon_{it}$$

Table 6
Results from Estimation of the Augmented Model

Dependent variable:	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
ln*o*	11.925 *	0.0876	-0.0191	-1.084 *
	(3.740)	(1.594)	(-0.186)	(-2.348)
ln*o*1	12.727 **	0.0747	0.5836 *	-2.002 **
	(2.651)	(0.899)	(2.387)	(-2.943)
ln*o*2	3.490 **	0.1561	0.7014 *	-0.5814
	(0.566)	(1.447)	(2.337)	(-0.644)
ln*o*3	13.118 **	0.0372	-0.1616 *	-1.251 **
	(4.204)	(0.694)	(-2.171)	(-2.756)
ln*o*4	7.004	0.0934	-0.4035 **	-0.5723
	(1.527)	(1.174)	(-4.734)	(-0.855)
ln*o*5	10.529	0.3264 **	-0.5865 **	-1.011
	(1.576)	(2.865)	(-3.272)	(-1.050)
ln*o*6	28.530 **	-0.0373	0.2863 **	-4.409 **
	(3.859)	(-0.288)	(2.612)	(-4.043)

These results show that the clearance rate has a significant effect on the crime rate for each of the offence groups. However, in half the cases a *positive* relation is found, contrary to the prior hypothesis. This is puzzling, in particular, as the clearance rate is given by the ratio of the number of crimes cleared to the total number of crimes reported and, hence, is a function of the dependent variable and, thus, an endogenous regressor. For instance, an overestimate of the number of crimes due to measurement error will lead to an underestimate of the clearance rate, thereby introducing a negative correlation between the error and the clearance rate, and a potential downward bias in γ. One possible reason for observing a positive effect nevertheless may be delays in the formation of beliefs. At the time potential offenders form their expectation of the clearance rate they do not

[12] They also included a measure of relative income (or income inequality), that was assumed to have a positive effect on crime.

know the current value, only the results of previous experiences and published statistics. This possibility is addressed below.

The level of income has a negative effect for every offence group and the overall crime rate. Contrary to Ehrlich (1973) and Entorf and Spengler, this suggests that the effect of an increase in legal income opportunities outweighs the effect of a corresponding increase in illegal income opportunities. The introduction of p and y has had little impact on the estimated effect the unemployment rate has on crime. The significance of $\hat{\beta}$ has increased for property abuse crimes, while for drug and anti-social offences $\hat{\beta}$ is no longer significant at the 5% level. There remains no evidence that the unemployment rate has a significant effect on the total crime rate.

Table 7
Testing the Significance of Auxiliary Regressions for the Augmented Model

Dependent variable:	F-statistic: [a]
$\hat{\mu}_i$ (one-way)	2.58
$\hat{\mu}_i$ (two-way)	6.90 **
$\hat{\lambda}_t$ (one-way)	2.89
$\hat{\lambda}_t$ (two-way)	5.18 *

[a] Critical values at the 1% and 5% levels, respectively, are 5.95 and 3.49 with $\hat{\mu}_i$ as a dependent variable and 6.99 and 3.86 with $\hat{\lambda}_t$ as a dependent variable.

As with the simple model, the efficiency of fixed effects estimation was tested by regressing the estimated effects on the explanatory variables, which are now ln*un*, ln*p* *and* ln*y*. Table 7 reports the results of tests that the coefficients on these three variables are jointly equal to zero. When either type of effect estimated from the two-way model is used, the F-statistic calculated is significant at the 5% level. This suggests that, contrary to the simple model, the fixed effects specification estimated above should be retained, as random effects estimation will introduce bias.

Including lagged clearance rate

As noted above, the inclusion of p as a regressor is problematic for two reasons. However, both of these can be overcome to some extent by using the previous year's clearance rate in the model, rather than the current year's rate. This leads to the following fixed effects specification:

$$\ln oj_{it} = \alpha + \mu_i + \lambda_t + \beta \ln un_{it} + \gamma \ln pj_{i(t-1)} + \delta \ln y_{it} + \varepsilon_{it}$$

The results of experimenting with applying this model to the data are presented in Table 8.

Table 8
Results from Estimation of the Augmented Model with Lagged Clearance Rate

Dependent variable:	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
ln*o*	11.6853 **	0.0029	-0.0413	-1.0063 *
	(3.390)	(0.046)	(-0.413)	(-2.010)
ln*o*1	15.1397 **	0.0051	0.1965	-2.0772 **
	(2.915)	(0.055)	(0.843)	(-2.825)
ln*o*2	5.0743	0.0758	0.4066	-0.6066
	(0.733)	(0.600)	(1.368)	(-0.600)
ln*o*3	12.7938 **	-0.0340	-0.2404 **	-1.1337 *
	(3.779)	(-0.554)	(-3.249)	(-2.299)
ln*o*4	2.7091	-0.1616	-0.2669 **	0.0225
	(0.545)	(-1.783)	(-3.154)	(0.031)
ln*o*5	9.2685	01885	-0.6802 **	-0.7454
	(1.257)	(1.426)	(-3.640)	(-0.701)
ln*o*6	26.5430 **	-0.1959	0.0084	-3.9025 **
	(3.203)	(-1.291)	(0.076)	(-0.644)

Clearly, more evidence for the negative deterrence rate hypothesis has been generated, with the γ coefficients either negative or insignificant. This model has reported no significant link between unemployment and crime for any offence group.

5. Conclusions

So, having muddied further the already turbid waters of research into the unemployment-crime relationship, what has this study contributed? Evidence has been found that would seem to run counter to earlier conclusions reached by Small and Lewis for New Zealand. Results indicate that the total rate of crime is not significantly affected by the unemployment rate, once complicating factors are controlled for. In addition, of the offence groups classified by the New Zealand Police, only property abuse offences exhibit a noticeable link to the unemployment rate. Unemployment was found to have no significant relationship to the number of dishonesty crimes committed. This is the category that includes the economic crimes of theft, fraud, car conversion, receiving and burglary that much of the previous literature, including Small and Lewis (1996), has focussed on.

It is quite possible that these divergent findings are a result of Small and Lewis' use of a bivariate analysis. This study has shown both income and the clearance rate to be important

determinants of the crime rate, whereas Small and Lewis chose to consider only the effects of unemployment. The findings presented in this paper would seem to suggest that the increasing crime problem of recent decades cannot be attributed to increases in unemployment, but rather to additional variables. As a consequence, policy makers may have greater success in combating crime by attempting to manipulate the deterrence rate and the average household income, among others.

Finally, this study indicates several possibilities for further research. In particular, the introduction of additional regressors that may explain crime, for example income inequality, may alleviate any remaining omitted variable bias. A theoretical comparison and evaluation of the different assumptions and results with respect to "causality tests" in panel data and pure time series data, respectively, will allow the findings of this paper to be contrasted with those of Small and Lewis.

As the title of this paper implies, the unemployment-crime relationship is an old issue. No consensus has been reached by economists during the past three decades, nor does one seem likely to emerge in the near future. Perhaps the observation by McDowell and Webb (1995) has particular relevance to this area of research: that this is an "urge to achieve a certainty which simply does not exist". Or perhaps with superior data and superior techniques a conclusive model of the crime decision may be found and, in the process, bring credibility to application of economic principles to social issues.

Appendix: Definitions of offence groups

Violent offences (*O1*)
- Homicide
- Grievous assaults
- Minor assaults
- Group assemblies
- Robbery
- Kidnapping/abduction
- Serious assaults
- Intimidation/threats

Drug and anti-social offences (*O2*)
- Drugs (not cannabis)
- Drugs (cannabis only)
- Gaming
- Liquor offences
- Disorder
- Vagrancy offences
- Family offences

Dishonesty offences (*O3*)
- Theft
- Fraud
- Car conversion
- Receiving
- Burglary

Property damage offences (*O4*)
- Destruction of property
- Endangering

Property abuse offences (*O5*)
- Firearms offences
- Littering
- Post, rail and fire abuses
- Animals
- Trespass

Sexual offences (*O6*)
- Sexual attacks
- Abnormal sex
- Sexual affronts
- Immoral behaviour
- Immoral behaviour/miscellaneous
- Indecent videos

Administrative offences (*O7*)
- Against justice
- Against national interest
- Births, deaths and marriages
- Immigration
- Race relations
- By-law breaches

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