Does Unemployment Increase Crime?
Evidence from U.S. Data 1974–2000

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ABSTRACT

OLS may understate the effect of unemployment on crime because of the endogeneity problem (Raphael and Winter-Ember 2001). In this paper, we use changes in the real exchange rate, state manufacturing sector percentages, and state union membership rates as novel instrumental variables to carry out 2SLS estimations. We find a one-percentage-point increase in unemployment would increase property crime by 1.8 percent under the OLS method, but that the elasticity goes up to 4 percent under 2SLS. The larger 2SLS effect has significant policy implications because it explains 30 percent of the property crime change during the 1990s.

I. Introduction

Crime imposes enormous economic costs on society,[1] with unemployment also considered important in the supply function of crime.[2] The coincidence between the longest economic expansion since World War II and the overall reduction in crime rates in the 1990s seems to confirm this argument. Between 1991 and 2000, there was a significant fall in the annual unemployment rate in the United States, from 6.8 percent to 4.8 percent. Furthermore, as noted by Levitt (2004), according to calculations based upon the *Uniform Crime Report* (*UCR*), over the same period, there were considerable reductions in acts of murder (-42.9

1. Miller, Cohen, and Wiersema (1996), for example, estimates that the annual cost of crime in the United States is about $450 billion, while Anderson (1999) subsequently raises the estimation to $1,100 billion; these respective figures are equivalent to $1,800 and $4,000 per capita per year.
2. For example, in the leading newspapers, "a strong economy" is the No. 6 explanation (ranked by frequency of citing) between 1991 and 2001 (Levitt 2004). In a report to the National Criminal Justice Commission, Donziger (1996) suggests that $1 billion should be spent to generate jobs for the disadvantaged in the inner city to reduce crime.

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percent), violent crime (-33.6 percent) and property crime (-28.8 percent). Such a strong correlation confirms to policymakers that reducing the level of unemployment is one of the most effective ways to fight crime.

Economists typically conclude that unemployment (or a decline in labor market conditions) can lead to an increase in crime, because the worsening opportunities in the legal employment sectors make committing crime more attractive (Becker 1968). Such a propensity is expected to have more relevance to property crime because of its pecuniary nature (Levitt 2004). In terms of empirical evidence, recent studies reach consensus that unemployment does have a positive, significant, but only small effect on property crime, and no significant effect on violent crime. In numerical terms, a one-percentage-point increase in unemployment increases property crime by 1–2 percent (Freeman 1995; Bushway and Reuter 2002; Levitt 2004). This trend is clearer when, as opposed to the average unemployment rate, better measures are used to identify those on the margin of committing crime.[3]

This paper provides a better means of identifying the causal link between labor market conditions and crime. I focus on breaking down the endogeneity between unemployment and crime, and on how the policy implications of the magnitude of the 2SLS estimations differ from those in the prior literature obtained under OLS estimations. Adopting U.S. state panel data, I use changes in the exchange rate, state union membership percentages, and state manufacturing percentages as novel instrumental variables in unemployment. I find that although a one-percentage-point increase in unemployment would increase property crime by 1.8 percent under OLS estimation, this elasticity goes up to between 4.0 and 6.0 percent under the 2SLS method. I also confirm that unemployment has no significant effect on violent crime.

Our results contribute to the existing literature in three ways. First of all, and quite surprisingly, although the more recent studies have shown that changes in labor market conditions can affect property crime with regard to those who are more likely to be on the margin of committing crime, attempts to control for endogneity remain rare.[4] As argued by Levitt (2001), when using panel data, the instrumental variable approach is a preferable means of identifying the link between crime and unemployment, since simultaneity, omitted variables, and measurement error can all lead to bias in the OLS results. To the best of our knowledge, only Raphael and Winter-Ember (2001) and Gould, Weinberg, and Mustard (2002) attempt to explore the instrumental variable (IV) method, although the measures they obtained are quite different.[5]

Given that our 2SLS estimates are twice the size of the OLS estimates, this also confirms the suspicions of Raphael and Winter-Ember (2001) that the available evidence understates the effects of unemployment on crime.[6] The 2SLS results

3. See for example, Freeman (1995), Grogger (1998), and Gould, Weinberg, and Mustard (2002), where young, unskilled and low-educated males are the main groups of interest.

4. As noted by Piehl (1998), most of the prior literature treats the economy as "exogenous".

5. Raphael and Winter-Ember (2001) finds that the elasticity of unemployment on property crime was around 2.8–5.0 per cent under 2SLS; however, the 2SLS estimations found by Gould, Weinberg, and Mustard (2002) are very close to those under OLS (1.8–2.0 per cent).

6. The two reasons suggested are "a failure to control for those variables which exert procyclical pressure on crime rates (the problem of omitted variables) … to the extent that criminal activity reduces the employability of offenders (the problem of simultaneity)". Measurement error in unemployment would also induce the same result (see Section III of this paper for a more detailed discussion).

obtained in this study consequently contribute to the literature by better controlling for endogeneity, thereby providing more precise estimations than those reported in the prior literature.

Secondly, the magnitude of our 2SLS estimations also points to very different policy implications than may have previously been considered. As opposed to the traditional results of 1–2 percent under the OLS method, there is a two- to threefold increase in the 2SLS estimates of the effect of unemployment on property crime, rising to about 4.0–6.0 percent. This indicates that the two-percentage-point reduction in unemployment in the 1990s would reduce property crime by between 8.0 and 12.0 percent. This also would explain about 33 percent of the property crime change (10/30) over the same period.[7] The effect is about the same size as the effect of the legalization of abortion (Donohue and Levitt 2001). However, if, as suggested in the prior OLS literature, elasticity is only 1.0-2.0 percent, then unemployment may have only a minor role to play, if any role at all, in the reduction in crime in the 1990s (Levitt 2004).

Finally, although the recent literature shows that average unemployment may not be an appropriate measure—in terms of identifying those who are at the financial margins of committing crime—our results show that such a positive effect can still be identified if endogeneity is properly controlled. This may be because the variations picked up in the present study through the IV method are for those people working in manufacturing who are thus more likely to be substituted by foreign competition.[8] Our study adds support to the growing opinion within the literature that, when better measures are obtained, there is increasing evidence of labor market conditions affecting crime.

The remainder of this paper is organized as follows. Section II reviews the extant literature, followed in Section III by a description of the data and a discussion of the identification problem. The empirical results are presented in Section IV, where I justify the use of the instruments by building up a causal link between exchange rate fluctuations, union membership and unemployment. We then undertake a comparison of the 2SLS and OLS results in Section V, and Section VI concludes.

II. Literature Review

The theoretical approach to the ways in which economic incentives affect criminal behavior can be seen in Becker (1968), Ehrlich (1973), and various later works. With unemployment, the opportunity cost of committing a crime—namely, the legal wage—declines, which makes illegal income more appealing. A graphic version of this argument can also be seen in Grogger (2000) and Raphael and Winter-Ember (2001). This prediction is also likely to be more relevant for property crime, which leads to direct financial gain (Levitt 2004).

As to the empirical evidence, the early studies on the positive effect of unemployment on crime are described as ''inconsistent, insignificant, and weak'' (Chiricos

7. In numerical terms, according to the 2SLS estimations, reducing unemployment by one 0 percentage point would save about $20 billion to $100 billion in crime costs.

8. That is, the male, low-wage, low-education workers.

1987). Furthermore, there is surprisingly little evidence to support the proposition that crime rates are driven by economic conditions (Piehl 1998); this has, however, changed over the past ten years, with the more recent articles consistently reporting the positive, significant, and small effects of unemployment on property crime, but not on violent crime.

Using the OLS method and U.S. panel data on states, counties and cities, a number of studies find that a one-percentage-point increase in the unemployment rate increases property crime by just 1–2 percent.[9] Using time series data on New York City, Corman and Mocan (2005) find that elasticity was about 1.8-2.2 percent for only burglary and motor theft, while Papps and Winkelmann (2002) also find the elasticity of unemployment on property crime to be 2.0 percent in their examination of data on New Zealand. Nevertheless, Entorf and Spengler (2000) calculate the elasticity of unemployment on total crime in Germany as around just 0.5 percent.[10]

Such significant changes can be attributed to three factors. First, recent studies are better at identifying relevant variables because average unemployment or wage measures may not be appropriate for identifying those on the margin of committing crime. From their focus on young, unskilled, and low-educated males, Gould, Weinberg, and Mustard (2002) find that a one-percentage-point increases in the unemployment rate of this ''at-risk'' group would increase property crime by only 1–2 percent. Machin and Meghir (2004) also found strong evidence to support the effect on crime from conditions in the low-wage labor market.[11] The second factor is recognizing the need to control the potential problems caused by endogeneity; however, to the best of our knowledge, only Raphael and Winter-Ember (2001) and Gould, Weinberg, and Mustard (2002) make such attempts by using 2SLS. The third factor is that we are now at a much better stage in terms of extensively controlling for the independent variables, as well as in the usage of panel data, given that the periods under examination are now much longer.

The overall picture from the above literature and many of the survey articles is that unemployment has a small, positive and significant effect (of about 1–2 percent) on property crime only; however, most of the results have been generated under the OLS method which does not control for endogeneity. In the only two studies that adopt the use of instrumental variables, the magnitude of the effects obtained, and hence the policy implications, are very different.[12]

9. See for example, Levitt (1996, 1997, 1998, 2001), Donohue and Levitt (2001) Raphael and Winter-Ember (2001) and Gould, Weinberg, and Mustard (2002).

10. However, Butcher and Piehl (1998) could not reject the hypothesis that unemployment had no effect on any crime. Ruhm (2000) even found that unemployment was negatively correlated with murder. Lin (2006) found a larger effect of unemployment on theft using Taiwan's data.

11. See also Freeman (1995) and Grogger (1998).

12. Raphael and Winter-Ember (2001) uses oil price shock weighted by a state's percentage of manufacturing employees as an instrumental variable and find that the elasticity of unemployment on property crime under 2SLS was around 2.8-5.0 percent. Gould, Weinberg, and Mustard (2002) uses the initial industrial composition and the national composition trend in state employment as the instrumental variables; however, the 2SLS estimations are very close to those under OLS (2.0 per cent).

This research, therefore, sets out to add to the literature by using a set of novel instruments to solve the rarely discussed problem of endogeneity and by discussing the differences in the estimations as well as their impact on crime policy.

III. The Data and the Problem of Identification

A. The Data

The data used in this paper comprise a panel of 49 U.S. states with observations covering the period 1974–2000.[13] Following Levitt (1996), seven crime categories from the *UCR* are included. These are murder, rape, assault, and robbery, collectively referred to as "violent crime," and burglary, larceny and auto theft, collectively referred to as "property crime." The overall numbers of local and state police forces are also listed in the *UCR*.

The total number of prisoners and details on the use of the death penalty are obtained from the *Criminal Justice Statistics Source Book* produced by the Bureau of Justice, while the figures for the total consumption of ethanol per person are taken from the website of the National Institute of Alcohol Abuse and Alcoholism. The remaining demographic and economic incentive variables, which include state income per capita, hourly wages, unemployment rates, state public aid, health and education expenditures, the proportions of metropolitan residents and African-Americans, poverty levels, age structure, and the AFDC (TANF) per recipient family per year, are taken from various issues of the *Statistical Abstract of the United States*.

As to the instrumental variables, the real exchange rates are taken from the historical data archives at the Federal Reserve Bank of New York, and the oil price series can be found in the *Annual Energy Review* published by the Department of Energy within the U.S. Central Government. The percentages of employees in manufacturing, manufacturing value, and union membership are also taken from various issues of the *Statistical Abstract of the United States*.

The summary statistics provided in Table 1 show that between 1974 and 2000, approximately 5,000 crimes were committed each year for every 100,000 persons in the United States, albeit relatively minor property crimes in the great majority of cases. The table also shows that there were approximately 237 prisoners, 250 local police, and 30 state police per 100,000 of the population. The average state expenditure per capita per year was $380 on public welfare, $540 on education, and $130 on health, while the average hourly wage was $9.76. Approximately 76 percent of the population lived in urban areas, with African-Americans accounting for about 12 percent of the total population.

As to the key variables, the average unemployment rate was 6.30 percent and the price of oil was $24.93 per barrel. The manufacturing sector accounted, on average, for 20.01 percent of state total employees and 19.25 percent of all state GDP, with 21.8 percent of the workers holding union membership at state level.

13. The District of Columbia and Hawaii are excluded since they do not have state police numbers; however, the results are basically the same when the observations of these two states are included (by omitting the state police variable).

Table 1
Summary Statistics, Weighted by Population, 1974–2000

Summary Statistics	Mean	Standard Error
Instrumental variables		
Change in real exchange rate (percent)	0.13	4.98
State manufacturing employee numbers (percent)	20.01	0.07
State manufacturing GDP (percent)	19.25	6.92
State union membership (percent)	21.84	11.12
Oil price (per barrel)	24.93	11.40
Dependent variables		
UCR crime rate (per 100,000 population)		
Violent crime	573	265
Murder	8.44	4.05
Rape	33.7	12.8
Assault	319	157
Robbery	210	134
Property crime	4,516	1241
Burglary	1,214	433
Larceny	2,792	808
Auto theft	503	226
Independent variables		
State expenditures[a]		
State public welfare expenditures	0.38	0.29
State educational expenditures	0.54	0.29
State health expenditures	0.13	0.11
Socioeconomic variables		
Unemployment (percent)	6.30	2.01
Local police (per 1,000 population)	2.50	0.71
State police (per 1,000 population)	0.30	0.11
Prisoners (per 1,000 population)	2.37	1.57
AFDC[b]	5,881	2726
ln income per capita	9.91	0.36
Hourly wage	9.27	3.51
African-American (percent)	12.06	8.08
Metropolitan (percent)	76.74	17.51
Poverty (percent)	13.45	3.75
Age 15–17 (percent)	4.83	0.80
Age 18–24 (percent)	11.43	1.59
Age 25–34 (percent)	15.71	1.89
Ethanol [c]	1.95	0.40
Death penalty (Yes = 1)	0.68	0.47
Crack index	1.11	1.27

Notes:
a. State education expenditures, state public welfare expenditures, and state health expenditures are US$1,000 per capita, and are adjusted by the CPI.
b. AFDC is per recipient family per year (TANF after 1997).
c. Ethanol is gallons consumed per capita per year.

B. The Problem of Identification

In general, three factors can explain bias in the OLS results, the first of which is the problem of omitted variables. If, for example, any procyclical crime-related commodity consumption is omitted, then the OLS method would underestimate the true effects (Raphael and Winter-Ember 2001).[14] Cook and Zarkin (1985) suggest that legitimate employment opportunities, criminal opportunities, crime-related commodities, and the responses by the criminal justice system are all important variables in the crime supply function. In this paper, we use unemployment rates, state income per capita, hourly wages, and poverty rates as independent variables to represent the economic incentive factors. Special attention should be paid to hourly wage and poverty rates, because wages and the economic conditions of lower percentile workers are very important to the determination of crime (Grogger 1998; Gould, Weinberg, and Mustard 2002; Machin and Meghir 2004).[15]

Other control variables include state education, public aid and health expenditures (government spending), prisoner and police numbers,[16] the death penalty (deterrence), alcohol (crime-related goods), age structure, and metropolitan percentages. To further control for unobserved variables that do not follow a specific trend or that do not change overtime, we add in state, year, and state-specific linear and quadratic trends as control variables to explore fully the advantages of our state panel data.[17] Although it is not possible to prove that all the relevant independent variables have been included in the specifications, our main conclusions hold, both with and without state trend dummies, and also remain insensitive to the inclusion or exclusion of particular control variables.

The second possible explanation for bias in OLS estimations is the problem of simultaneity between crime and unemployment. The overall effect of unemployment may be underestimated under OLS if criminal activity reduces the employability of offenders (Raphael and Winter-Ember 2001) or if crime increases unemployment because of employer flight (Cullen and Levitt 1999). The third explanation is that the OLS method would underestimate the effect as a result of a random measurement error in unemployment.

Overall, as noted by Raphael and Winter-Ember (2001), omitted variables and simultaneity lead to some suspicion that the available evidence understates the effect of unemployment on crime. If this is true, then we should see the 2SLS estimates of the effect of unemployment on property crime being both positive and consistently larger than the OLS estimates, and indeed, this is the major finding in our empirical results section.

14. The finding by Ruhm (1995) that there is a positive relationship between alcohol consumption and economic conditions legitimizes this concern.

15. Within our sample, the average wage is around $9 per hour, which can be used, to some extent, to represent the wage of low skill workers.

16. As argued by Levitt (2004), the impact of the economy on crime is indirect (through state and local government budgets, both of which are highly correlated with macroeconomic performance). Including state-expenditure variables, such as expenditures on education, prisons, police, welfare, and health programs, can avoid any bias of this nature.

17. See Marvel and Moody (1996), Friedberg (1997), and Raphael and Winter-Ember (2001).

IV. Emprical Results

A. OLS Regression Results

In the first instance, we report the OLS results as a reference point under the following specifications:

$$\ln(Crime\ ijt) = \rho Unemployment\ it + \beta Xit + \phi i + Year\ t + \phi i^{*} Year\ t + \phi i^{*} Year\ t^{2} + \xi ijt \quad (1)$$

where the dependent variables are different crime rates, *j* indicates the crime category, *i* is state, *t* is year, *Xit* represents all the independent variables outlined earlier in Table 1, ϕi and *Year t* represent state and year dummies, and the final two terms are state specific linear and quadratic linear trends.

For each crime category, we present three different specifications by gradually adding in linear and quadratic linear trends. The results are presented in Table 2.

As can be seen from Table 2, for property crime, the effects of the unemployment rate are positive and significant at the 99 percent level. When state and year dummies and other independent variables are added, the elasticity is 0.026, or 2.6 percent. After adding in the linear and quadratic linear trends, the respective estimates become 1.1 percent and 1.8 percent. It is clear, therefore, that unemployment has a positive and significant, but relatively small, effect on property crime. However, its effects on violent crime are insignificant because economic incentives often play a much smaller role in violent crime vis-à-vis property crime.

Alcohol consumption is positively related to violent crime, and we also find that more prisoners, more police, higher per capita income, the death penalty, and fewer young people all result in crime reduction. Overall, the standard specification shows that a 1.0 percentage point increase in unemployment can increase property crime by around 1.1 to 1.8 percent, although it has no significant impact on violent crime. This result is similar to those reported in the prior literature.

B. Instrumental Variables and the First-stage Results

As noted earlier, the OLS results may contain bias stemming from omitted variables, simultaneity, or simple measurement error. To obtain a consistent estimator, we need to find an instrumental variable, *Z*, which will only affect crime rates through unemployment. Hence the two conditions for a valid IV are relevance, namely Cov (*Z*, Unemployment) $\neq 0$, and exogeneity, Cov (Z, μ) $= 0$. According to Levitt (1997) and Angrist and Krueger (2001), the three criteria that must be met are: (i) detailed knowledge of the economic mechanisms and institutions for the instrumental variables selected; (ii) an overidentification test if there are more IVs than endogenous variables; and (iii) a weak IV test.

In this paper, we use the changes in the real exchange rate between adjacent years, $RERC\mathrm{t} = \frac{RER_{\mathrm{t}} - RER_{t-1}}{RER_{\mathrm{t}-1}}$, multiplied by the percentage of state manufacturing sector employees or GDP value (that is, *RERC*it=*RERC*t**Manufacturing* percent it) to instrument unemployment. It should be noted that the real exchange rate (RER) is calculated by the average foreign exchange rates of all trade partners weighted by trade

Table 2
OLS Results of Unemployment and State Demographic Variables on Property and Violent Crime, 1974–2000[a]

Variables	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Panel A: Property Crime			ln Property Crime [b]			
Unemployment	0.026***	0.003	0.011***	0.002	0.018***	0.002
ln income per capita	−0.533***	0.106	−0.441***	0.131	−0.199**	0.097
ln hourly wage	0.130**	0.066	0.093	0.061	0.000	0.019
ln local police rate *t*-1	−0.047	0.039	−0.149***	0.043	−0.049	0.032
ln state police rate *t*-1	−0.005	0.008	−0.002	0.003	−0.001	0.002
ln prisoner rate *t*-1	−0.210***	0.018	−0.180***	0.021	−0.130***	0.020
ln AFDC (or TANF)	0.031	0.022	0.009	0.017	0.025	0.018
Poverty rate (percent)	−0.010***	0.002	−0.004	0.001	0.000	0.001
Metropolitan (percent)	0.001***	0.000	0.001**	0.000	0.001**	0.000
African-American (percent)	0.961	0.612	3.203***	0.963	−3.186***	1.115
ln ethanol per capita	0.938***	0.071	0.037	0.085	−0.145**	0.072
ln state education expenditures	0.070***	0.025	0.119***	0.028	0.004	0.017
ln state public expenditures	0.040**	0.019	−0.012	0.022	0.012	0.019
ln state health expenditures	0.011	0.010	0.007	0.007	0.002	0.004
Age 15–24 (percent)	3.035***	0.598	4.303***	0.593	2.089***	0.717
Age 25–34 (percent)	3.409***	0.540	5.580***	0.707	3.653***	0.772
Death penalty	−0.096***	0.017	−0.069***	0.017	−0.035***	0.013
State and year dummies	Yes		Yes		Yes	
Linear trend dummies	No		Yes		Yes	
Quadratic trend dummies	No		No		Yes	
F statistics	199.49		264.43		397.13	
Adjusted R^2	0.9280		0.9618		0.9775	
Number of observations	1323		1323		1323	

(*continued*)

Table 2 (*continued*)

Variables	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Panel B: Violent Crime			ln Violent Crime [b]			
Unemployment	0.005	0.004	−0.007**	0.004	−0.004	0.003
ln income per capita	−0.227	0.171	−0.188	0.166	−0.065	0.142
ln hourly wage	−0.263	0.198	0.076	0.048	0.013	0.042
ln local police rate *t*-1	−0.051	0.048	−0.131***	0.050	−0.012	0.047
ln state police rate *t*-1	0.018*	0.010	0.001	0.005	0.003	0.004
ln prisoner rate *t*-1	−0.091***	0.023	−0.143***	0.029	−0.131***	0.027
ln AFDC (or TANF)	−0.024	0.033	−0.036	0.033	−0.032	0.030
Poverty rate (percent)	0.001	0.003	−0.004*	0.002	0.002	0.002
Metropolitan (percent)	0.001	0.001	0.000	0.001	−0.000	0.000
African-American (percent)	−1.939***	0.794	2.155	1.832	−3.060	2.253
ln ethanol per capita	0.766***	0.102	0.426***	0.029	0.331***	0.127
ln state education expenditures	−0.001	0.041	0.071*	0.038	−0.097***	0.030
ln state public expenditures	0.010	0.026	0.048	0.029	0.035	0.027
ln state health expenditures	0.043***	0.014	0.016**	0.009	0.012*	0.008
Age 15–24 (percent)	2.863***	0.700	3.974***	0.869	2.257*	1.296
Age 25–34 (percent)	6.703***	0.872	6.508***	1.154	4.874***	1.099
Death penalty	−0.134***	0.028	−0.083***	0.022	−0.095***	0.022
State and year dummies	Yes		Yes		Yes	
Linear trend dummies	No		Yes		Yes	
Quadratic trend dummies	No		No		Yes	
F statistics	346.97		434.69		528.54	
Adjusted R^2	0.9496		0.9685		0.9785	
Number of observations	1323		1323		1323	

Notes:
a. Regressions are weighted by population.
b. *** indicates significance at the 99percent level; and ** indicates significance at the 95 percent level.

volume. By weighting the manufacturing employee percentage, we can measure the specific RERC shock (dollar appreciation or depreciation) to which each state is exposed in any given year. This is the strategy adopted by Raphael and Winter-Ember (2001), in which oil costs are used as the instrumental variable.

The effects of exchange rate movement and unemployment, particularly in the manufacturing sector, are well documented in the prior literature. As argued by Revenga (1992), the link between dollar appreciation and industry employment is "straightforward," because any change in import competition that leads to a shift in industry product demand will tend to shift employment in the same direction. In theory, currency appreciation can affect the domestic labor market by altering profit (Sheets 1992; Clarida 1997), investment (Campa and Goldberg 1999) or production location (Goldberg 1993). As to the prior empirical estimations, Branson and Love (1988) finds that the U.S. manufacturing sector lost over one million jobs as a direct result of the 1981-85 appreciation of the U.S. dollar.

Using industry level manufacturing sector data covering the period between 1977 and 1987, Revenga (1992) finds that import prices appeared to have a sizable effect on employment. A number of other studies also reports that most of the adjustments to an adverse trade shock came through employment.[18] In addition, since exchange rate equilibrium is determined in the global money market, although the United States is a relatively large economy within that market, it is unlikely that any state-specific unemployment rate change (the variation used in our 2SLS estimations) would affect overall U.S. exchange rates.

Furthermore, using macro-level variables as instruments for micro-level decisions is not uncommon within the literature (see for example, Evans and Ringel 1999; Currie and Moretti 2003). Let us also consider whether exchange rates are correlated with certain omitted variables that may affect crime but may not have been controlled within the regression. To address this issue, we control for the economic variables such as hourly wages, per capita income, state education, public aid, and health expenditures, each of which may be correlated with exchange rate shocks, and also may affect crime rates. We also include state, year, and trend dummy variables to identify those variables that are not included in the independent variables. Of course, the list cannot be exhaustive and we acknowledge the possible pitfall in our analysis here.

In addition to using the percentage of state employees and the percentage of GDP accounted for by the manufacturing sector, we also use the percentage of state union membership as our weighting for real exchange rate movements. As noted by Freeman and Medoff (1984), unions are simply "organizations [that] have monopoly power which they can use to raise wages above competitive levels." As a consequence, an excess supply of labor is created due to the deviation from the competitive market equilibrium, resulting in unemployment.[19]

We have so far introduced three weighting methods, the percentage of state manufacturing sector employees, the percentage of state manufacturing sector

18. See for example, Belman and Thea (1995), Gourinchas (1998), Burgess and Knetter (1998), Kletzer (2000), Goldberg and Tracy (2000), and Campa and Goldberg (2001).

19. Lewis (1985), Layard and Nickell (1986), Freeman and Kleiner (1990), Linneman, Wachter, and Carter (1990), and Jarrell and Stanley (1990) each report the existence of the large union wage premium and its negative effect on employment.

GDP and the percentage of state union membership, as the real exchange rate change variables. We also add in oil prices (weighted by these three variables) as the instrumental variables for comparison with Raphael and Winter-Ember (2001). The justification for the impact of oil shocks on unemployment can be seen in Davis and Haltiwanger (1999), in which they document the effect of oil shocks on the U.S. manufacturing sector.

We can now begin our 2SLS analysis. In the first stage we run:

$$\begin{aligned} &Unemployment\,it = \sigma IVit + \beta Xit + \phi i + Year\,t \\ &+ \phi i^{*} Year\,t + \phi i^{*} Year\,t^{2} + \xi it \end{aligned} \tag{2}$$

where *Xit* refers to all of the state expenditures and social economic variables used in Equation 1. Our instrumental variables are the two macroeconomic variables weighted by the three different procedures: (i) RERC * state manufacturing sector employee percent; (ii) RERC * state manufacturing sector GDP percent; (iii) RERC * state union membership percent; (iv) oil prices * state manufacturing sector employees' percent; (v) oil prices * state manufacturing sector GDP percent; and (vi) oil prices * state union membership percent. Once the first-stage results are obtained, the predicted value of unemployment will replace the observed unemployment rates in Stage 2, namely, Equation 3:

$$\begin{aligned} &\ln(Crimeijt) = \rho Unemployment\,it + \beta Xit + \phi i + Year\,t \\ &+ \phi i^{*} Year\,t + \phi i^{*} Year\,t^{2} + \xi ijt \end{aligned} \tag{3}$$

Table 3 presents the first-stage results using real exchange rate movements. The positive and highly significant coefficient estimates indicate that dollar appreciation, along with manufacturing and union membership percentages, are positively correlated with the unemployment rate, which accords with our discussion in the previous section.

By carrying out a simple calculation, we can determine whether our estimation results are comparable with those of the earlier studies. We know that from 1980–85, the real exchange rate appreciated about 33 percent. As Column 1 of Table 3 indicates, the coefficient estimate of $RERC_t$*manufacturing employee $_{t\text{-}1}$ percent is 54, which means that the unemployment rate increase due to this appreciation would be 55*0.33 (dollar appreciation) * 0.2(mean of manufacturing employee percent) = 3.63 percent, or roughly four million unemployed people. This number is similar to the 4.0–7.5 percent unemployment estimated by Revenga (1992).

We also use state manufacturing percentage (GDP or employee numbers) plus union membership as a set of instrumental variables for the first stage when subsequently carrying out the overidentification test, with both the sign and significance of the coefficient estimates all fitting our prediction. Furthermore, as argued by Bound, Jaeger, and Baker (1995), Staiger and Stock (1997), and Stock and Yogo (2004), the first-stage joint *F*-test value should be large enough to pass the weak IV tests. Table 3 shows the *F*-statistics for the null hypothesis that all coefficient estimates of the instrumental variables in the first-stage regression are not jointly different from zero. They range from 21 to 58—significantly larger than the rule of thumb, 10, suggested by Stock and Watson (2003).

Table 3
First-Stage Results of the Effect of Changes in Real Exchange Rates on Unemployment[a,b]

Real Exchange Rate Changes (RERC)	(1)	(2)	(3)	(4)	(5)
$RERC_t$* State manufacturing $employee_{t-1}$ (percent)	53.96*** (8.64)	—	—	22.00*** (8.64)	—
$RERC_t$* State manufacturing GDP_{t-1} (percent)	—	47.49*** (7.90)	—	—	26.53** (8.47)
$RERC_t$* State $union_{t-1}$ (percent)	—	—	1.37*** (0.18)	1.15*** (0.19)	0.78*** (0.19)
Adjusted R^2	0.9065	9288	0.9103	0.9108	0.9246
F-statistics	63.54	63.39	68.33	68.59	69.40
Number of observations	1323	1323	1323	1323	1323
F-statistics for weak IV test (Prob>*F*)	39.00 (0.0000)	36.07 (0.0000)	58.43 (0.0000)	30.95 (0.0000)	20.95 (0.0000)

Notes:
a. Standard errors are in parentheses.
b. *** indicates significance at the 99 percent level; and ** indicates significance at the 95 percent level.

For the purpose of comparison, oil prices weighted by the three different methods are also used as instrumental variables. It should be noted that we do not put oil prices and exchange rate together because these two variables have high collinearity. The procedure is the same as that in Table 3. The results, which are presented in Table 4, indicate that oil price shocks weighted by manufacturing or union percentages lead to an increase in the unemployment rate; the weak IV test is also passed, with the single exception of Column 1.

C. 2SLS Regression Results

The final step in the 2SLS regression is to enter the predicted value of the unemployment rates obtained from Equation 2 into our second-stage regression, namely Equation 3. We first use "real exchange rate change * state manufacturing employees percent" to perform a single IV 2SLS regression. To test the sensitivity of the model specifications, we report the regression results by gradually adding in the state specific linear trend and quadratic trend dummy variables. The results are reported in Table 5.

As we can see, the OLS estimation of the elasticity of unemployment on property crime for the full model specifications is 1.62 percent. When the 2SLS method is used, the results range between 4.4 and 6.5 percent, consistently greater than the OLS results, and dependent on whether or not state specific linear or quadratic trends are included. Unemployment appears to have no significant effect on violent crime, in both the OLS and 2SLS estimations.

To investigate this issue further, we first use the six instrumental variables to obtain the first-stage prediction value of unemployment. We then use all seven *UCR* crime categories (murder, rape, assault, robbery, burglary, larceny, and auto theft) as the dependent variables to perform a single IV 2SLS regression using the full model specifications of Equation 3. The results are presented in Table 6.

It is clear that for property crime, the 2SLS estimations of unemployment elasticity for the six different single instrumental variables range between 2.5 and 5.5 percent, which is much greater than the OLS estimation (1.6 percent). Furthermore, the ranges of the respective 2SLS results for the property crime category (burglary, larceny and auto theft) were 2.1–6.6 percent, 1.6–5.4 percent and 4.1–15.8 percent. These are consistently greater than the OLS results (2.5 percent, 1.1 percent and 1.7 percent). The unemployment effect on violence is also insignificant, except for its negative relationship with rape (strong) and murder (much weaker).

Because we have six different IVs, we can use more than one IV in our 2SLS regression to perform an overidentification test. This can be carried out by regressing the predicted residuals of the 2SLS on all of the exogenous and instrumental variables, and then calculating the χ^2 value of n (the number of observations) x R^2. The results presented in Table 7 show that, with the exception of larceny, all of the crime categories pass the overidentification test, with most of the statistics being less than 2. This indicates that the 2SLS method remains insensitive to the instrumental variables chosen.

As to the estimation of unemployment elasticity, it is also clear that the 2SLS method produces 2.9–5.4 percent for property crime, 3.0–6.7 percent for burglary, 2.5–5.0 percent for larceny, and 4.7–8.0 percent for auto theft. Again, the effects of unemployment on violent crime are unclear, with the exception of the negative

Table 4
First-Stage Results of the Effect of Oil Prices on Unemployment

Oil-Price Effect	(1)	(2)	(3)	(4)	(5)
Oil price$_t$* state manufacturing employee$_{t-1}$ (percent)	0.09** (0.04)	–	–	0.01 (0.05)	–
Oil price$_t$ * state manufacturing GDP$_{t-1}$ (percent)	–	0.23*** (0.04)	–	–	0.15*** (0.04)
Oil price$_t$*state union$_{t-1}$ (percent)	–	–	0.01*** (0.00)	0.01*** (0.00)	0.004*** (0.001)
Adjusted R^2	0.8989	0.9135	0.9014	0.9014	0.9152
F-statistics	60.25	90.22	65.31	65.68	–
Number of observations	1,323	1,323	1,323	1,323	1323
F-statistics for weak IV test (Prob>F)	4.43 (0.0355)	31.27 (0.0000)	27.81 (0.0000)	13.90 (0.0000)	23.23 (0.0000)

Notes:
a. Standard errors are in parentheses.
b. *** indicates significance at the 99 percent level; and ** indicates significance at the 95 percent level.

Table 5
OLS and 2SLS Results of the Effect of Unemployment on Property and Violent Crime

Variables	OLS	2SLS	2SLS	2SLS
Panel A: Property Crime		ln Property Crime		
Unemployment	0.018***	0.065***	0.056***	0.045***
	(0.002)	(0.018)	(0.017)	(0.011)
Other independent variables	Yes	Yes	Yes	Yes
State and year dummies	Yes	Yes	Yes	Yes
Linear trend	Yes	No	Yes	Yes
Quadratic trend	Yes	No	No	Yes
Adjusted R^2	0.9775	0.9099	0.9452	0.9737
Number of observations	1323	1323	1323	1323
F-statistics	397.13	133.92	164.95	–
Panel B: Violent Crime		ln Violent Crime		
Unemployment	-0.004	-0.017	-0.011	-0.021
	(0.004)	(0.020)	(0.019)	(0.015)
Other independent variables	Yes	Yes	Yes	Yes
State and year dummies	Yes	Yes	Yes	Yes
Linear trend	Yes	No	Yes	Yes
Quadratic trend	Yes	No	No	Yes
Adjusted R^2	0.9785	0.9473	0.9681	0.9776
Number of observations	1323	1323	1323	1323
F-statistics	528.54	340.35	426.51	–

Notes:
a. The instrumental variable is 'Real Exchange Rate Change*State manufacturing employees percentage'; standard errors are in parentheses.
b. *** indicates significance at the 99 percent level.

effects for both rape and murder. These numbers are similar to the single IV results presented in Table 6, and also similar to those reported by Raphael and Winter-Ember (2001).

So far, we show a greater effect of unemployment on property crime under the 2SLS method than under the OLS method. However, we can find no significant effect of unemployment on violent crime. Our results also pass the first-stage weak IV test and the overidentification test, and remain robust across different model specifications. There are, however, several issues in need of further attention; these are discussed in the following section.

V. Discussion

The first issue of importance is the negative sign of unemployment on violent crime, though some of them are insignificant. In some model specifications,

Table 6
Single Instrumental Variable Results on the Effect of Unemployment on Different Crime Categories[a]

Variables	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Property crime	0.018***	0.045***	0.038***	0.025***	0.116**	0.030***	0.055***
	(0.002)	(0.011)	(0.010)	(0.009)	(0.057)	(0.010)	(0.016)
Burglary	0.025***	0.027*	0.039***	0.038***	0.038	0.021*	0.066***
	(0.003)	(0.014)	(0.013)	(0.012)	(0.040)	(0.013)	(0.021)
Larceny	0.011***	0.054***	0.038***	0.016**	0.161**	0.032***	0.055***
	(0.002)	(0.012)	(0.010)	(0.008)	(0.078)	(0.009)	(0.016)
Auto theft	0.017***	0.056***	0.041*	0.046**	0.158*	0.049**	0.081**
	(0.005)	(0.022)	(0.023)	(0.021)	(0.096)	(0.025)	(0.036)
Violent crime	−0.004	−0.021	−0.002	−0.021**	−0.064	−0.035*	−0.109***
	(0.004)	(0.015)	(0.016)	(0.015)	(0.059)	(0.019)	(0.033)
Murder	−0.002	−0.018	−0.014	−0.040**	−0.136	−0.058**	−0.022
	(0.005)	(0.021)	(0.022)	(0.018)	(0.088)	(0.026)	(0.025)
Rape	−0.007**	−0.056***	−0.033**	−0.060***	−0.289**	−0.073***	−0.091***
	(0.004)	(0.016)	(0.014)	(0.014)	(0.137)	(0.019)	(0.026)
Assault	−0.004	−0.029	−0.001	−0.039***	−0.056	−0.034*	−0.016
	(0.004)	(0.018)	(0.018)	(0.015)	(0.062)	(0.020)	(0.025)
Robbery	0.008*	0.025	0.021	0.002	0.051	−0.002	−0.023
	(0.005)	(0.023)	(0.023)	(0.021)	(0.074)	(0.024)	(0.033)
Instrumental variables[b]	No	(A)	(B)	(C)	(D)	(E)	(F)

Notes:
a. Instrumental variables are: (A) real exchange rate change* state employee percentage in the manufacturing sector; (B) real exchange rate* state GDP percentage in the manufacturing sector; (C) real exchange rate change* state union membership percentage; (D) oil price * state employee percentage in the manufacturing sector; (E) oil price* state GDP percentage in the manufacturing sector; (F) oil price* state union membership percentage.
b. All crime rates are in log form; standard errors are in parentheses; *** indicates significance at the 99 percent level; ** indicates significance at the 95 percent level; and * indicates significance at the 90 percent level.

Table 7
Multiple Instrumental Variable and Overidentification Test Results on the Effect of Unemployment on Different Crime Categories

Variables	OLS	2SLS	2SLS	2SLS	2SLS
Property crime	0.016***	0.030***	0.030***	0.028***	0.054***
	(0.002)	(0.009)	(0.009)	(0.009)	(0.016)
Burglary	0.025***	0.036***	0.037***	0.031***	0.067***
	(0.003)	(0.011)	(0.012)	(0.012)	(0.021)
Larceny	0.011***	0.024***	0.025***	0.026***	0.053***
	(0.002)	(0.008)	(0.008)	(0.008)	(0.016)
Auto theft	0.017***	0.048**	0.044**	0.055**	0.080**
	(0.005)	(0.020)	(0.022)	(0.024)	(0.036)
Violent crime	−0.002	−0.021	−0.006	−0.017	−0.021
	(0.004)	(0.014)	(0.015)	(0.015)	(0.025)
Murder	−0.002	−0.036**	−0.027	−0.078***	−0.109***
	(0.005)	(0.017)	(0.020)	(0.023)	(0.033)
Rape	−0.007**	−0.059***	−0.039***	−0.054***	−0.087***
	(0.004)	(0.013)	(0.013)	(0.016)	(0.026)
Assault	−0.004	−0.037**	−0.019	−0.017	−0.015
	(0.004)	(0.015)	(0.016)	(0.015)	(0.025)
Robbery	0.008*	0.007	0.016	−0.008	−0.025
	(0.005)	(0.020)	(0.022)	(0.023)	(0.033)
Instrumental Variables[b]	No	(A)	(B)	(C)	(D)
Rejection of overidentification test at the 5 percent level[c]	No	Property, Larceny	Larceny	None	Rape, Larceny

Notes:
a. Instrumental variables are: (A) real exchange rate change* state employee percentage in the manufacturing sector + real exchange rate change* state union membership percentage; (B) real exchange rate* state GDP percentage in the manufacturing sector + real exchange rate change* state union membership percentage; (C) oil price* state GDP percentage in the manufacturing sector + oil price* state union membership percentage; (D) oil price* state employee percentage in the manufacturing sector + oil price* state union membership percentage.
b. All crime rates are in log form; standard errors are in parentheses; *** indicates significance at the 99 percent level; ** indicates significance at the 95 percent level; and * indicates significance at the 90 percent level.
c. The overidentification test $[\chi^2] = nR^2$. The critical value of χ^2 (1) = 3.84 at the 5 percent significance level, and 6.63 at the 10 percent significance level.

unemployment also has a significant negative effect on murder (weak) and rape (very strong). Although unemployment can increase property crime, the negative correlation between unemployment and violent crime is not immediately obvious from the theory. Furthermore, the positive effect of unemployment on robbery is also generally weak, which is somewhat strange, since the motivation for committing robbery—namely, economic gain—is similar to that for property crime. We offer two alternatives for reconciliation of this point.

First, the overall unemployment rate may not be capable of identifying people on the margin of committing a particular crime, even after controlling for endogeneity. For example, since almost all rape offenders are male, the gender-specific unemployment rate should be a better measurement than the overall unemployment rate. Indeed, Raphael and Winter-Ember (2001) show that while overall unemployment has a significant negative impact on rape, this effect became positive (although not significant) when the male unemployment rate is used.

Second, as pointed out by Raphael and Winter-Ember (2001), the failure to control for crime-related commodity variables, such as alcohol, guns, and drugs, each of which demonstrate procyclical pressure, can lead to underestimation of the true effects of unemployment. Levitt (2004) also argued that since most crime-related commodities, such as alcohol and cocaine, were normal goods, improvements in economic conditions can have a negative impact on crime. It is likely that we obtain a negative unemployment effect on violent crime because we do not control variables that are procyclical and have particularly profound effects on violent behavior; cocaine appears to be one of them.[20]

To explore this point further, we include the "state crack cocaine index" calculated by Fryer et al. (2005)—which includes data from 1980–2000 only—as a control variable into all of our OLS and 2SLS regressions. The process is essentially the same as those outlined in Equations 2 and 3. The results presented in Table 8 show that when adding the crack index and using data from 1980-2000, the effect of unemployment on violent crime (including both murder and robbery) becomes positive (although not significant). Furthermore, the estimates of unemployment on robbery are about 5–7 percent less than the 2SLS method, which is similar to the effect on property crime. This shows when a proper measure of crime-related commodity is used as a control variable the effect of unemployment on violent crime becomes positive, small, and insignificant. Nevertheless, the positive, significant, and larger estimates of unemployment on property crime under the 2SLS method remain.

Finally, we also attempt to introduce as many combinations of the independent variables as possible, and find that the results are not at all sensitive to the inclusion or exclusion of any particular controls; that is, unemployment has a significantly positive effect on property crime, with the magnitude of the effect larger under the 2SLS methods. Nevertheless, one might suspect that employment conditions among certain particular demographic groups may drive our results. This direction may well be worthy of further investigation if more detailed data were to become available.[21]

20. Blumstein and Rosenfeld (1998), Grogger and Willis (2000), Levitt (2004), and Fryer *et al.* (2005) all argue that cocaine is a major explanatory variable in violent crime in the United States.

21. We replace the overall unemployment rates by "age 16 to 19," "male," manufacturing sector, and "African-American" unemployment rates; however, none of the results are significant.

Table 8
U.S. State Data on the Effect of Unemployment on Different Crime Categories with the Inclusion of the Cocaine Index as an Independent Variable, 1980–2000[a]

	OLS[b]		2SLS[b]	
Variables	(1)	(2)	(3)	(4)
Property Crime	0.018***	0.093***	0.083***	0.060**
	(0.002)	(0.023)	(0.022)	(0.025)
Burglary	0.025***	0.093***	0.074***	0.061***
	(0.003)	(0.025)	(0.023)	(0.030)
Larceny	0.015***	0.015***	0.094***	0.065***
	(0.002)	(0.002)	(0.024)	(0.024)
Auto Theft	0.013***	0.102***	0.066***	0.035
	(0.005)	(0.054)	(0.035)	(0.047)
Violent Crime	0.006	0.011	−0.019	0.016
	(0.004)	(0.025)	(0.026)	(0.035)
Murder	0.004	0.020	−0.022	0.002
	(0.006)	(0.041)	(0.033)	(0.046)
Rape	−0.002	−0.028	−0.083***	−0.028
	(0.004)	(0.024)	(0.027)	(0.030)
Assault	0.149	−0.018	−0.028	0.007
	(0.242)	(0.029)	(0.027)	(0.040)
Robbery	−0.020***	0.074*	0.049	0.057
	(0.006)	(0.042)	(0.0413)	(0.052)
Other independent variables[b]	Yes	Yes	Yes	Yes
Cocaine index	Yes	Yes	Yes	Yes
State and year dummies	Yes	Yes	Yes	Yes
Linear trend	Yes	No	Yes	Yes
Quadratic trend	Yes	No	No	Yes

Notes:
a. The instrumental variable is exchange rate change * state manufacturing GDP percentage; all crime rates are in log form; standard errors are in parentheses; *** indicates significance at the 99 percent level; ** indicates significance at the 95 percent level; and * indicates significance at the 90 percent level.
b. All other independent variables used in the previous tables are included.

IV. Conclusion

Obtaining a precise measure of the impact of unemployment on crime is very important, insofar as it facilitates a cost-benefit analysis for the assessment of possible public policy interventions. Although economic theories predict that unemployment should have a positive effect on property crime, most of the prior literature has reported that a one-percentage-point increase in the unemployment rate is

associated with a 1.0 percent increase in property crime, but not violent crime (Levitt 2004). However, most estimates are obtained under the OLS method, which does not control for endogeneity.

In this paper, we begin with a discussion of the ways in which the problems of omitted variables and simultaneity can lead to bias in the OSL estimations. We control for an extensive set of independent variables, including deterrence, economic conditions, demographics, year and state dummies, and state-specific linear and quadratic trends, so as to mitigate the problem of omitted variables. We then use a set of novel instrumental variables, namely changes in the real exchange rate, state union membership percentage, oil prices, and state manufacturing employee percentages to mitigate the problem of simultaneity.

Our first-stage regression shows that appreciation in the U.S. dollar and in oil prices, together with union membership and manufacturing employee percentages, have a strong positive effect on unemployment. Furthermore, the results of the first-stage easily pass the weak IV test. In the second-stage analysis, we show that the 2SLS estimation of the elasticity of unemployment on property crime is 4-6 percent for the full model specifications, as compared to the 1.8 percent obtained under the OLS method. The fact that the 2SLS results are consistently greater than those obtained under the OLS method indicates that the two major sources of bias stemming from the OLS method are the positive response of unemployment to the problem of crime, and the omitted variables which cause crime, but which are negatively correlated with unemployment (procyclical).

As for violent crime, there is no apparent significant effect attributable to unemployment, in either the OLS or 2SLS estimations. We also use the overidentification test in an attempt to reveal the sensitivity of the choice of instrumental variables; however, with the single exception of larceny, all of the 2SLS results hold. Finally, our results remain insensitive to both the different model specifications and the choice of independent variables.

The 4–6 percent estimates obtained in this study on the effect of unemployment on property crime have important policy implications, since they indicate that roughly one-third of the reduction in property crime during the 1990s may have been attributable to changes in unemployment, a conclusion that is very different to those drawn in much of the prior literature.

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