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WELFARE PAYMENTS AND THE SPREAD OF AIDS IN THE UNITED STATES

Rand W. Ressler, Melissa S. Waters,
John Keith Watson, R. Carter Hill

Address for Ressler and Watson:
Department of Economics and Finance
University of Louisiana at Lafayette
Lafayette, LA 70504-4570
Phone (337) 482-6662
Fax: (337) 482-6675
e-mail (Ressler): rwr5011@louisiana.edu

Address for Waters:
Department of Economics
Southern University
Baton Rouge, LA 70813

Address for Hill:
Department of Economics
Louisiana State University
Baton Rouge, LA 70803

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I. Introduction

The history of the HIV/AIDS epidemic began 20 years ago in the United States when the first reports of a previously unrecognized illness were reported to the federal Centers for Disease Control and Prevention (CDC) in Atlanta. These cases involved Pneumocystis Pneumonia and Kaposi's sarcoma among male homosexuals in Los Angeles and New York. In the succeeding years, the face of the American HIV epidemic has changed from one primarily involving whites, to one in which the majority of those infected are members of nonwhite minority groups. From an epidemic whose original victims were male homosexuals or intravenous drug users, the mode of transmission of the HIV virus has expanded to a much broader base. Heterosexual transmission, particularly affecting females, now plays a much larger role.

Between 1981 and 2001 in the United States, 793,026 AIDS cases were reported to the CDC. During this time, the deaths of 457,667 men, women, and children were caused by AIDS.[1] Approximately 40,000 new HIV cases occur each year in the United States, and roughly 30% of these are now women. The CDC estimates that 75% of these newly infected women contracted HIV through heterosexual contact. Worldwide, 40 million people are estimated to be living with HIV or AIDS, and during 2001 alone, an estimated 3 million people died of AIDS. Approximately 48% of adults living with HIV or AIDS worldwide are women.

As an example of the changing face of AIDS in the United States, from the mid 1980s to the mid 1990s, the number of women with AIDS increased from 8% to 21% (67% of these cases were from heterosexual transmission); the proportion of whites dropped from 60% to 43%; cases among homosexuals and bisexuals dropped from 64% to 44%; and the proportion of cases attributed to

heterosexual transmission increased from 3% to 13%.

Currently in the U.S., blacks make up about 38% of all reported AIDS cases. Almost two-thirds of all women with AIDS are black. As of 2000, the rate of reported AIDS cases among black Americans was twice the rate for Hispanics and 8 times the rate for whites. In the U.S., AIDS has become increasingly a disease of poor Americans. The changing pattern of HIV/AIDS infections may be attributed in some small part to government policy.

Economists believe, and often demonstrate, that incentives matter. In particular, economic incentives affect individual behavior in predictable ways. This belief extends to all human behavior from the decisions on corporate mergers to the decisions on sexual activities.[2] The decision to engage in various activities, including sexual activities, is based on expected benefits and expected costs which may be altered through public policy. Economists have studied many issues involving the effects of public income transfers and the incentives that they create. A frequently studied topic is the effect of welfare payments on various aspects of behavior, such as labor market participation and fertility. Some studies have found a positive relationship between welfare payments and illegitimate fertility rates. Increases in the relative size of these welfare payments (in particular, Aid to Families with Dependent Children, or AFDC) decrease the expected cost of illegitimate children and thereby lower the price, or expected cost, of premarital and unprotected sex.

In this paper, we extend the above argument and take the analysis one step further. If AFDC payments lower the expected costs of unprotected sex, then states with higher AFDC payments should experience higher rates of heterosexual HIV and AIDS cases, other things equal. Using state-wide data over the years 1993 through 1996, we hypothesize a positive relationship between the size of welfare payments per recipient and the heterosexual HIV infection rate.

Section II contains a brief review of the economic literature

surrounding welfare payments and illegitimate fertility rates. Only a few economic studies examine any issues involving AIDS, and none addresses the relationship between heterosexual HIV or AIDS rates and the economic incentives provided by welfare payments. Section III describes epidemiological and data issues. Section IV contains a description of the model, and Section V the econometric methodology and empirical results. Finally, Section VI provides a brief summary and conclusion.

II. The Literature

The impact of economic incentives on the decision to have sex and, therefore, children, has been addressed in the literature for hundreds of years. As summarized by Clarke and Strauss (1998), Malthus (1798), Blaug (1978), and, more recently, Becker (1991) have all taken an economic approach to explaining people's desire to have children. The early economists viewed children as investment goods, i.e., they were income-producing assets. However, contemporary economists most often view children as consumption goods providing utility directly to the parents.

Clarke and Strauss combine these views of children to provide a comprehensive study of the effects of welfare payments (AFDC, and food stamps), on the rate of illegitimate births to teenagers. They suggest that among low-income individuals, children are viewed not only as consumption goods, but also as a source of income from welfare payments. By modeling a woman's utility as a function of children, consumption, family income, and leisure, they find that AFDC payments and other forms of welfare have contributed to the rapid increase in the rate of illegitimate births since the end of World War II. Other researchers have found similar results (Caudill and Mixon, 1993). Not all economic studies, however, support the positive relation between AFDC payments and illegitimate births, (see Moffitt, 1992, and Murry, 1993, for summaries).

The responsibility for AFDC payments was shared by both federal and state governments. The federal government imposed broad guidelines for the implementation of the program, while states determined the level of benefits and administered the program. The level of benefits in each state was determined by that state's standard level of need along with the recipients' level of income. Consequently, payments varied greatly from state to state. For example, in 1994 the average monthly payment per recipient in Mississippi was $42.91 while in Alaska it was $246.78. The average of all states in 1994 was $133.55.

Whether or not increases in AFDC payments actually increase the number of illegitimate births is not as important to this study as is the fact that the existence of AFDC payments lowers the expected costs of unprotected sex for men and women within the target group of welfare recipients. This target group consists largely of low income, poorly educated, disadvantaged unwed teenage girls and women. Many will note that providing economic security to low income females should have the opposite effect on fertility than what we propose: they argue that fertility should decrease as women become more empowered. We certainly agree that the long-term effects of a successful poverty reduction program will be to empower women through increases in education and income levels, and thus may reduce fertility rates. Our contention, with which there is little argument, is that the AFDC program was not a success in eliminating or even largely reducing core poverty rates, in part because its incentive structure was adverse. The Welfare Reform Law of 1996 essentially ended the federal entitlement to assistance. Effective July 1, 1997, AFDC was replaced by the Temporary Assistance for Needy Families (TANF) program, which placed emphasis on individual state policies designed to promote work, responsibility and self-sufficiency in exchange for time-limited assistance.

III. Epidemiological Issues and Data Limitations

AIDS stands for acquired immunodeficiency syndrome, and describes a collection of so-called "AIDS indicator illnesses" as defined by the CDC. AIDS is caused by the human immunodeficiency virus, or HIV. HIV is spread through contact with bodily fluids such as blood, semen, vaginal fluid, breast milk, and other bodily fluids containing blood. The HIV virus damages the immune system over time, eventually allowing an AIDS indicator illness to develop, at which time the HIV-positive individual is diagnosed with AIDS.

The time lag, or incubation period, between HIV contraction and AIDS diagnosis can vary widely. Though the median incubation period from HIV infection until development of AIDS is approximately 10 years for young adults, substantial variation is reported across patients (Bacchetti and Moss, 1989). The incubation period can be as short as one year, and has an upper limit which is still unknown and has currently reached at least 20 years. The incubation period also varies based on age at contraction, and is shorter in both infants and older adults (Rosenberg, et al., 1994). Since AIDS was recognized as a new clinical syndrome in 1981, medical advances have increased the incubation period for many HIV infected individuals (and decreased the death rate for AIDS diagnosed individuals).

Due to the incubation period from HIV to AIDS, a contemporaneous model linking welfare payments to AIDS contraction is not appropriate. A lagged model is not tenable, either, due to the wide variation in incubation periods among individuals (as well as changes in the median incubation period over time.) The use of HIV incidence as the dependent variable is clearly indicated. Further, we are interested in the transfer of HIV through heterosexual contact, which limits our data sources. While all 50 states and the District of Columbia report AIDS cases to the CDC, not all report new cases of HIV infection.[3] Among those states reporting HIV cases, there is a great deal of variation in the accompanying reporting of demographic and risk information. Unfortunately, published data on state-wide HIV incidence by exposure category (e.g., through heterosexual contact, homosexual contact,

receipt of blood transfusion, injecting drug use, etc.) are not available.

A limited amount of AIDS data has been published which indicates exposure category, or transmission mechanism, by state (only national data are readily available for both AIDS and HIV cases by exposure category). These data, the proportion of a state's total AIDS cases generated from heterosexual contact, have been published for the years 1993-1996. This dictates the size of our state-based data set.

In an attempt to roughly estimate the state-wide proportion of HIV cases caused by heterosexual contact, we extrapolate from the published 1993-1996 heterosexual AIDS data. Our dependent variable is an estimated heterosexual HIV rate per state: the proportion of a state's new HIV infections is multiplied by the proportion of its new AIDS cases caused by heterosexual contact for each year. (For example, if 5 percent of a state's newly reported AIDS cases are the result of heterosexual contact, we assume this same percentage also applies to the state's new HIV cases.) For our available time frame, 26 states consistently reported new HIV cases. These states are listed in Table 2.

IV. Model Specification

We specify the following model using data on the 26 reporting states for 1993-1996:

$$\text{HET-HIV Rate} = f(\text{AFDC, COLLEGE, IMPOP, DOCTORS, NOINSURE, AGE, BLACK, HEALTHEX YEAR94, YEAR95, YEAR96, REGION}_i) \quad (1)$$

Where:

- HET-HIV Rate is the number of new HIV cases multiplied by the proportion of all new AIDS cases which are caused by heterosexual contact, for each state,
- AFDC is the amount of the Aid to Families with Dependent Children payment, per recipient,[4]

- COLLEGE is the percentage of population with at least four years of college,
- IMPOP is the number of immigrants admitted per resident population,
- DOCTORS is the number of practicing doctors per 100,000 population,
- NOINSURE is the percentage of the population without health insurance,
- AGE is the percentage of the population aged 18-34,
- BLACK is the percentage of the population who are African-American,
- HEALTHEX is government spending on health care and hospitals per capita,
- YEAR94, YEAR95, and YEAR96 are dummy variables indicating year(1993 is the base year),
- $\mathbf{REGION}_i$ is a vector of regional dummy variables,[5]

The explanatory variable in which we are most interested is AFDC. As argued above, if higher AFDC payments lead to higher rates of fertility, it should also be the case that the sexual conduct required for pregnancy will put participants at risk for contracting HIV. Thus, in states with generous AFDC payments, single women will face lower costs of bearing and raising children and will be less likely to actively seek to prevent pregnancy. Our primary hypothesis is of a direct relationship between the magnitude of AFDC payments per recipient and new HIV cases caused by heterosexual contact.

Among the factors influencing fertility are labor market participation and opportunities, and earnings, all interrelated variables. COLLEGE is included to represent more highly educated and higher wage-earning women. Greater education may imply greater knowledge of the risks of transmitting disease through unprotected sex; in addition, higher-wage women have higher opportunity costs of childbearing and rearing. Thus, COLLEGE is expected to have a negative impact on the contraction rate of the HIV virus.

Historically, HIV was brought to the United States through international travel of Americans, and through immigration. Immigration has long been

associated with the spread of diseases, and it is unrealistic to think that HIV would differ from this pattern. In addition to this precedent, it may be the case that in many countries, particularly Developing Countries, individuals do not have access to the same level of health care that many enjoy in the U.S. These arguments must be tempered, however, with the knowledge that not all immigrants are from poor countries, nor are they all from low income backgrounds. We cautiously expect that the coefficient of IMPOP will be positive.

If the number of doctors in a state is an indication of access to health care, we anticipate a negative correlation between DOCTORS and the number of HIV/AIDS cases reported from all contact categories. However, it is more likely that the number of doctors is an indicator of availability to which many low-income individuals may not have practical access. On the other hand, a positive correlation may exist if HIV/AIDS infected individuals migrate to states with more doctors and better health care facilities. DOCTORS may not be exogenous, however, if doctors *themselves* migrate to states where a strong market for their services exists, perhaps due in part to greater HIV/AIDS prevalence. To control for this possibility, we test for the exogeneity of DOCTORS as discussed in the following section.

Individuals without health insurance may delay childbearing because of financial constraints. One might expect that at the margin, an increase in the (potential) cost of any activity - even unprotected sex - would act as a deterrent of sorts. If so, the coefficient of NOINSURE would be negative. However, neither women who currently receive welfare, nor many low income women who view AFDC payments as a viable future option, are likely to have private health insurance benefits. Among this group of individuals, a lack of private health care coverage may have little or no influence on fertility decisions. If true, NOINSURE may not significantly affect exposure to HIV. As a result, we have no strong a priori expectation on the sign attached to NOINSURE.

AGE represents the percent of the population aged 18-34. These are years in which fertility tends to be highest. Fertility rates also tend to be relatively high at the lower end of this range for low income females and minorities. In addition, young adults are more likely to be single and have multiple partners. For these reasons, we expect AGE to be positively associated with HET-HIV.

It has been well documented that the African American community has been particularly hard hit by the AIDS epidemic. African Americans account for 38% of all AIDS cases, while comprising only 11% of the population. Through the middle of 1996, African American women accounted for 55% of all female AIDS cases. Among intravenous drug users with AIDS, African Americans accounted for greater than 50% of cases. Almost 60% of all children with AIDS were African American.

We suspect the disproportionately large effect of AIDS on African Americans can be explained primarily by differences in socio-economic status, as characterized by education and income levels, and health care access. To account for unobservable and/or cultural characteristics which may play an additional role, we include BLACK and expect it to have a positive coefficient.

Government spending on health care is expected to lower the contraction rates of HIV/AIDS. This is primarily due to the educational and prevention efforts put forth by the government-subsidized health care community. As with DOCTORS, however, one might expect HEALTHEX to be endogenous in the model if areas with greater HIV/AIDS prevalence receive more health care funds as a result. Again, we test for the exogeneity of HEALTHEX as discussed in the following section.

Throughout much of the 1990s, annual rates of newly reported AIDS cases in the United States have steadily declined. During this time period, however, the CDC estimates that the annual number of new *HIV* infections has remained roughly stable. Annual dummy variables are included to test for

structural shifts which may have occurred in heterosexual HIV rates over time, and which are not otherwise accounted for by the continuous explanatory variables. It is well documented that in the HIV/AIDS epidemic, women are increasingly affected, and that heterosexual transmission plays an increasing role. However, the limitations of HIV surveillance and thus available HIV data make hypotheses regarding the annual dummy variables tenuous at best. Accordingly, with 1993 as the base year, we have no firm a priori expectations on the signs of the coefficients on YEAR94, YEAR95, and YEAR96.

In addition to the included variables, cultural norms which are characteristic of a particular region may contribute to the variation in the AIDS rate across the United States. Among these are religious attitudes and affiliation, political allegiance, and social mores reflecting tolerance and diversity, for example. These norms, or patterns of behavior characteristic of a particular group, are unobservable variables. Proxy variables must be used, whether measured directly (by an ordinal scale reflecting tolerance of alternative sexual lifestyles), or indirectly (by the number of needle-exchange programs, or state or regional dummy variables). We use 8 regional dummy variables to capture immeasurable and/or unobservable cultural differences across regions. The New England region is the base category, and we do not have strong expectations about the sign or significance of these coefficient estimates.

V. Econometric Methodology and Empirical Results

The data used in this paper are a cross-section of N=26 states observed over a period of T=4 years. Using standard notation let:

$$y_{it} = x'_{it}\beta + Y'_{it}\gamma + e_{it}, \qquad i = 1, \ldots N; \qquad t = 1, \ldots, T \tag{2}$$

The scalar y_{it} is the value of the dependent variable (HET-HIV Rate) for state i at time period t. The vector x'_{it} is a $(1 \times k)$ vector of previously defined

exogenous variables (the eight regional dummies; YEAR94, YEAR95, YEAR96; and the continuous variables AFDC, AGE, COLLEGE, IMPOP, NOINSURE and BLACK) with parameter vector β. The $(1 \times m)$ vector Y'_{it} contains the two possibly endogenous variables, DOCTORS and HEALTHEX, with parameter vector γ. The error term e_{it} is assumed to have 0 mean and variance σ_i^2, $i = 1, \ldots, N$.

In order to test for the possibility that the variables DOCTORS and HEALTHEX are endogenous, we use the regression based "Hausman Test" described in Wooldridge (2002, Chapter 6.2.1). First, however, we must estimate their reduced forms. To do so, we specified a $(1 \times g)$ vector z'_{it} of instrumental variables that are not included in x'_{it}. The instruments used are: percentage of the population living in metropolitan areas; personal income per capita; average wage of 18 to 34 year olds; and two measures of religious affiliation, percent Catholic and percent Jewish. The latter two are included as rough proxies for state-wide cultural differences influencing health care demand and quality. In vector and matrix notation the model is

$$y = X\beta + Y\gamma + e \tag{3}$$

Before implementing the Hausman test, we wished to determine how good our specified instruments actually are. Accordingly, we tested the quality of our instruments for DOCTORS and HEALTHEX in two different ways. First, we tested whether the instruments provide useful information about DOCTORS and HEALTHEX. In order to be useful, they must provide information in addition to that provided by the exogenous explanatory variables in the model, the x'_{it}. Following the suggestion of Wooldridge (2002, p.92) we estimated auxiliary regressions with dependent variables DOCTORS and HEALTHEX, respectively, and right-hand-side variables x'_{it} and z'_{it}. We then test the joint significance of the coefficients in z'_{it}. For both regressions, we reject the null hypothesis that the coefficients are zero at the .01 level of significance. We thus

conclude that our instruments do help explain the potentially endogenous variables, DOCTORS and HEALTHEX.

As a test of instrument validity, note that we have $g = 5$ instrumental variables when only $m = 2$ are required, resulting in $g - m = 3$ over-identifying restrictions. We tested for the validity of the instruments in the sense that they are not correlated with the error term, using a regression based test again described in Wooldridge (2002, chapter 6.6.2).[6] Essentially, we are testing whether the over-identifying instruments are uncorrelated with the regression error e. The value of the Chi-square test statistic is 3.92 with a *p*-value of 0.27. Thus, we fail to reject the null hypothesis of no correlation, and conclude that our instruments are satisfactory.

Having made this conclusion, we implemented the Hausman Test to determine whether DOCTORS and HEALTHEX should be treated as exogenous or endogenous.[7] This test has as its null hypothesis that the variables in Y (DOCTORS and HEALTHEX) are uncorrelated with the error term e. If we reject this hypothesis then we conclude that Y is endogenous and that we should apply Two Stage Least Squares (2SLS) estimation. If we fail to reject the hypothesis then we are justified in using a simple least squares or generalized least squares procedure. In our case, the Wald test statistic value is 8.0572934, wit a *p*-value of 0.0177984. Thus, we reject the null hypothesis at the .05 level of significance, and conclude that DOCTORS and HEALTHEX are endogenous, and that 2SLS is an appropriate estimator.

We used a 2SLS estimation procedure that accounts for the cross-sectional heteroskedasticity in the error vector *e*. We first estimated the model in (3) by 2SLS, using the full set of instruments $W = X \mid Z$, obtaining the 2SLS residuals $\hat{e}$. We obtained estimates of the error variances σ_i^2, $i = 1, \ldots, N$, using the consistent estimator

$$\hat{\sigma}_i^2 = \sum_{t=1}^{T} \hat{e}_{it}^2 \Big/ T, \qquad i = 1, \ldots, N . \tag{4}$$

We then divide through both sides of equation (2) by $\hat{\sigma}_i$ to yield the weighted regression

$$\frac{y_{it}}{\hat{\sigma}_i} = \frac{x_{it}'}{\hat{\sigma}_i}\beta + \frac{Y_{it}'}{\hat{\sigma}_i}\gamma + \frac{e_{it}}{\hat{\sigma}_i} \tag{5}$$

Now, for example, applying OLS to this transformed equation yields the feasible generalized least squares (FGLS) estimator. Similarly, applying 2SLS to (5), with the instruments similarly weighted, yields "weighted" 2SLS. Henceforth we assume that our data have been transformed in this way.[8]

The 2SLS results are contained in Table 3. Tables 1 and 2 provide various descriptive statistics on AIDS, HIV, and welfare payments for the years of analysis.

The positive and statistically significant coefficient on AFDC confirms our primary hypothesis. States with higher AFDC payments are associated with higher mean heterosexually transmitted HIV rates. This supports the economic theory that children may be viewed as income-producing assets among low-income individuals. By lowering the costs of unprotected sex and thus increasing its incidence, the individuals involved are at greater risk of contracting the HIV virus, which leads to AIDS.

Of the remaining continuous variables, COLLEGE, IMPOP, BLACK, DOCTORS, and HEALTHEX are all statistically significant and have the anticipated sign. The positive coefficient on DOCTORS is consistent with a migration of doctors to areas with a high demand for health care, and does not support a link between availability of and access to health care, at least for low income individuals. The significance of the estimated coefficient on BLACK is particularly high, and is consistent with the well-known demographic pattern of the HIV/AIDS epidemic in the United States. As was cautiously anticipated,

states with a higher percentage of immigrants are associated with higher rates of heterosexually transmitted HIV.

From a public policy perspective, the significance of HEALTHEX is intriguing. The results indicate that states with more government provided health care have significantly lower contraction rates of heterosexually transmitted HIV. Educational efforts regarding HIV and "safe sex" may be included in the variable HEALTHEX. The effectiveness of government spending in reducing contraction rates presents an interesting cost-benefits question, which should be pursued in future research.

Of the three included year dummies, only the coefficient on 1994 is significant, and it is positive. This implies that between 1993 and 1994, a positive structural shift in the heterosexual HIV rate model occurred. No such shift occurred in 1995 or 1996, however. It should be emphasized that these results are generated from our nonrandom sample of 26 reporting states. In this sample, mean estimated heterosexual HIV rates increased substantially from 1993 to 1994, then declined in each of the following two years, although remaining higher than the mean 1993 rate. Obviously, all inferences are confined to this 26 state sample.

Each of the seven included geographical dummy variables is significant and positive. Holding constant all other included explanatory variables, all geographic regions have higher rates of per capita estimated heterosexual HIV cases than New England. This may reflect unobservable cultural differences across regions contributing to variations in HIV incidence, as well as variations in HIV reporting procedures across states.

VI. Conclusion

Some studies have established that AFDC payments are positively related to rates of fertility and illegitimacy. This paper presents the next logical step by recognizing that an increase in fertility must be accompanied by an increase in unprotected sex. Thus, AFDC payments

serve to lower the costs (or potential costs) of engaging in unprotected sexual relations, a consequence of which is a greater risk of contracting HIV and AIDS. Using statewide data for the 26 reporting states from 1993 through 1996, our expectations appear confirmed: The size of the per recipient AFDC payment positively influences the heterosexual HIV rate.

This result may prove to be provocative as policy makers continue to debate issues of welfare reform and propose changes in the Welfare Reform Law of 1996, which expires in late 2002. It appears that neither politicians nor economists have yet succeeded in bringing relief to the socially disadvantaged without creating undesirable incentives. The limitations of the data available for this analysis restrict general inferences. However, these results represent a useful starting point from which it is hoped additional economic research will be generated. Comparisons between the effects of the AFDC program and the TANF program could prove particularly illuminating from a policy perspective. With additional research, a decisive determination may be made concerning the link between public assistance and the HIV/AIDS epidemic in the United States.

TABLE 1

Descriptive Statistics for AIDS, Heterosexual AIDS, AFDC per recipient:1993-1996 for all 50 States and the District of Columbia

	Mean	Standard Deviation
Heterosexual AIDS*	179.31 (1993)	336.96
	159.86 (1994)	309.34
	160.29 (1995)	286.69
	161.96 (1996)	282.35
All AIDS	2027.5 (1993)	3741.9
	1532.9 (1994)	2896.9
	1415.1 (1995)	2535.3
	1327.6 (1996)	2395.5
AFDC (per recipient)	123.30 (1993)	45.55
	124.42 (1994)	45.41
	123.81 (1995)	45.22
	122.86 (1996)	44.28

*Seven states either did not report separate figures specifying heterosexual AIDS contraction, or reported zero heterosexual AIDS cases for some or all years. These states are: Alaska (1994-96), Idaho (1996), Montana (1993-96), North Dakota (1993-96), South Dakota (1993-96),Vermont (1995-96), Wyoming (1993-96).

TABLE 2

Descriptive Statistics for HIV, Estimated Heterosexual HIV: 1993-1996

	Mean	Standard Deviation
Estimated Heterosexual HIV*	59.04 (1993)	83.90
	75.55 (1994)	128.49
	64.94 (1995)	79.28
	61.74 (1996)	73.43
All HIV	574.69 (1993)	621.77
	684.92 (1994)	983.48
	505.96 (1995)	515.64
	464.38 (1996)	452.20

*Twenty-six states reported HIV numbers for all four years: Alabama, Arizona, Arkansas, Colorado, Connecticut, Idaho, Indiana, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Nevada, New Jersey, North Carolina, North Dakota, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Utah, Virginia, West Virginia, Wisconsin, Wyoming.

TABLE 3
2SLS Estimates
(Corrected for Cross-sectional Heteroskedasticity)

Dependent Variable is HET-HIV RATE

Variable	Parameter Estimate	t Value	Pr > |t|*
Intercept	-0.02631	-3.10	0.0026
afdc	0.000080	3.90	0.0002
age	-0.00019	-0.61	0.5460
college	-0.00028	-2.25	0.0269
impop	0.002240	3.54	0.0007
noinsure	-0.00016	-1.06	0.2932
black	0.001594	15.32	<.0001
doctors	0.000048	2.40	0.0187
healthex	-7.98E-6	-5.85	<.0001
midatlan	0.045832	6.05	<.0001
souatlan	0.020427	8.07	<.0001
escentra	0.017309	5.10	<.0001
wscentra	0.016959	5.54	<.0001
encentra	0.020701	6.34	<.0001
wncentra	0.018251	7.96	<.0001
mountain	0.020671	6.45	<.0001
dummy94	0.001440	2.25	0.0273
dummy95	0.000340	0.46	0.6461
dummy96	0.000434	0.51	0.6131

* denotes 2-tailed p-value. If $p < \alpha$, where α is level of test significance, then the null hypothesis that the parameter value is zero is rejected in favor of the alternative that it is not equal to zero.

APPENDIX

The following are the 9 regions defined in the United States Census. We utilized 8 regions, since our 26-state sample did not include any states in the Pacific region. The omitted category is New England.

NEW ENGLAND: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island.
MIDDLE ATLANTIC: New York, Pennsylvania, New Jersey.
SOUTH ATLANTIC: West Virginia, Maryland, Delaware, Virginia, North Carolina, South Carolina, Georgia, Florida, District of Columbia.
EAST SOUTH CENTRAL: Kentucky, Tennessee, Mississippi, Alabama.
WEST SOUTH CENTRAL: Louisiana, Arkansas, Oklahoma, Texas.
EAST NORTH CENTRAL: Wisconsin, Michigan, Illinois, Indiana, Ohio.
WEST NORTH CENTRAL: North Dakota, South Dakota, Minnesota, Nebraska, Iowa, Kansas, Missouri.
MOUNTAIN: Montana, Idaho, Wyoming, Utah, Colorado, Arizona, New Mexico, Nevada.
PACIFIC: Washington, Oregon, California, Alaska, Hawaii.

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NOTES

[1] All figures in the Introduction are found on the CDC website: http://www.cdc.gov/.

[2] An exhaustive treatment of sexual behavior and its relation to costs and benefits can be found in Posner's Sex and Reason (1992).

[3] In December 1999, the CDC issued guidelines recommending that all states adopt name-based HIV surveillance. As of July 2001, 34 states have implemented name-based HIV case reporting to the CDC.

[4] Due to the lack of a published state by state cost-of-living index, monetary variables are in nominal terms.

[5] Definitions of the regional dummies are contained in the Appendix.

[6] The test statistic is $(NT)R^2$, (where NT = 104, the total number of observations) from the regression of the Two Stage Least Squares residuals $\hat{e}$ on the full set of instruments $W = X \mid Z$, and R^2 is the usual R-squared. Under the null hypothesis that the over-identifying instruments in W are uncorrelated with the regression error e, then $(NT)R^2 \approx \chi^2_{(g-m)}$, in large samples.

[7] The procedure is as follows: First estimate the reduced form equation $Y = W\Pi + V$, where $W = X \mid Z$, and obtain the reduced form residuals $\hat{V}$. Then estimate the model $y = X\beta + Y\gamma + \hat{V}\theta + error$ (*) by OLS. OLS is consistent under the null hypothesis that Y is exogenous. For the null hypothesis $H_0 : \theta = 0$ the Wald statistic is $(SSE_R - SSE_U)$, where these are the restricted sum of squared errors (from the model (*) excluding $\hat{V}$) and the unrestricted sum of squared errors from (*), respectively. The dimension of θ is $(m \times 1)$ where m = 2, and under the null hypothesis the Wald statistic is asymptotically $\chi^2_{(m)}$.

[8] Notes are in order about this estimation procedure: (i) we use the 2SLS residuals so that even if the variables in Y are endogenous, our estimator $\hat{\sigma}_i$ is consistent; (ii) given the estimated weights, this is the procedure by the computer software SAS (V8.2) when PROC SYSLIN for 2SLS is invoked with the WEIGHT statement; (iii) it is true that the sample size T used in the calculation (3) is small. However, there is substantial evidence that when modeling heteroskedasticity, as long as the estimated variances indicate the general pattern of heteroskedasticity, then the resulting FGLS estimates (and presumably the weighted 2SLS estimates we use) are robust. See, for example, Greene (1997, Chapter 12.6).