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The Research Agenda: Dynamic Models of Crime and Punishment, by Antonio Merlo

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An important phenomenon of the last decade has been the sharp and steady decline in crime. In the United States, the crime rate per 100 inhabitants was equal to 5.95 in 1980 and dropped to 5.09 in 1996. While this general trend has been observed for most categories of crime, the most noticeable decline has been observed for property crimes (that is, burglary, larceny, robbery, and motor vehicle theft), which account for over 90% of all crimes. The property crime rate per 100 inhabitants in the United States went down 17% from 5.60 in 1980 to 4.65 in 1996.

What accounts for this decline? Both the popular press and the academic literature have been searching for answers to this important question (See for example the article "Crime in America: Defeating the bad guys" in The Economist of October 3, 1998 and the collection of articles in the 1998 Summer issue of the Journal of Criminal Law and Criminology). Several main factors have been identified as possible explanations for this phenomenon. The first is related to demographics. It is well documented that most crimes are committed by youths. Their fraction in the population has being declining in the 1990s. For instance, the fraction of people between the ages of 15 and 25 was 20.5% in 1980 and went down to 15.1% in 1996.

Another key factor is related to law enforcement. Expenditures on police protection have increased from 0.6% of GDP in 1980 to 0.7% of GDP in 1996. Also, many initiatives to change the "style of policing" have been implemented in many U.S. cities. As a result, the clearance rate (i.e., the fraction of crimes cleared by arrest) has been increasing. For example, in 1980 the clearance rate for property crimes was equal to 16.8. In 1996, it increased to 18.5. At the same time, the "severity" of punishment has remained pretty much constant. For example, the expected punishment for property crimes (measured by the average length of prison sentences multiplied by the fraction of offenders sentenced to prison) was equal to 12.5 and 12.3 months in 1980 and 1995, respectively.

There are also other important phenomena that have been taking place in the 1990s that must be taken into consideration when trying to account for what is happening to crime. In particular, changes in the structure of earnings, employment opportunities, and the

skill composition of the work force are likely to be intimately related to changes in the level of criminal activity. The following observations all seem to point to a reduction in crime. Real earnings have been increasing. Average real earnings increased by approximately 10% between 1980 and 1996. At the same time, aggregate unemployment has been decreasing and so has the fraction of unskilled individuals in the labor force. For example, the fraction of individuals in the labor force with less than a high school degree has declined substantially between 1980 and 1996.

Other observations, however, point in the direction of an increase in crime. Income inequality has been increasing. By virtually any measure, the distribution of real earnings has become substantially more unequal over the past twenty years. In addition, youth unemployment has been increasing. For example, the unemployment rate for people between the ages of 15 and 19 was equal to 17.1 in 1980 and rose to 17.8 in 1996.

These observations raise important questions. First, are these factors sufficient to explain the observed decline in property crime evidenced between 1980 and 1996? Second, what is the quantitative effect of each one of these factors on property crime? Third, what is the relation between individual economic opportunities, public policies, and property crime? Providing answers to these questions is one of the main goals of my research agenda, conducted in collaboration with Ayse Imrohoroglu (University of Southern California) and Peter Rupert (Federal Reserve Bank of Cleveland). The emphasis on property crime is justified by the fact that unlike violent crimes, property crimes are typically motivated by the prospect of direct pecuniary gain. Economic considerations are therefore most likely to guide individual decisions of engaging in this type of criminal activities.

The main ideas presented here come from a working paper, "What Accounts for the Decline in Crime?" (Imrohoroglu, Merlo, and Rupert (2001)). Some of the ideas are also drawn from an article recently published in the International Economic Review entitled "On the Political Economy of Income Redistribution and Crime" (Imrohoroglu, Merlo, and Rupert (2000)).

To guide our quantitative investigation of the major determinants of observed patterns of property crime, we specify a dynamic equilibrium model with heterogeneous agents. The agents in our model differ ex ante with respect to their income earning abilities. In each period of their finite life, agents receive a stochastic employment opportunity. After knowing their employment status, they decide how much to save and whether to engage in criminal activities in that period. Criminal activities amount to stealing from other agents in the economy. If agents choose to commit a crime, they may be apprehended and punished.

There is a long tradition of economic models of crime initiated by Becker (1968), see for example Harris (1970), Stigler (1970), Ehrlich (1973), and Polinsky and Shavell (1984). Our model shares many of the features of existing models and embeds Becker's paradigm in a dynamic equilibrium framework. The dynamic nature of our model allows us to investigate individual decisions to engage in criminal activities over the life cycle. The

equilibrium aspect of our model allows us to investigate the response of the aggregate crime rate to a variety of factors. We calibrate our model using U.S. data for 1980 so as to reproduce the observed property crime rate. We then use 1996 data to evaluate the effect of changes in demographics, police activities, the distribution of wages, employment opportunities, and the skill composition of the work force on crime.

Our main findings can be summarized as follows. First, the model is capable of reproducing the drop in crime between 1980 and 1996. In particular, the combined effect of the changes in unemployment rates, earnings profiles, age distribution of the population, shares by human capital type, and the ability of the police to capture criminals that have occurred between 1980 and 1996 can account for about 90% of the observed decline in property crime.

Second, the most important factors that account for the observed decline in property crime are (in order of importance): the higher apprehension probability, the stronger economy, and the aging of the population. In particular, the higher apprehension probability alone would have amounted to a 43% decrease in the crime rate, the higher income to a 20% decrease, and the smaller fraction of youth in the population to a 11% decrease.

Third, the effect of unemployment on crime is negligible. This finding is mostly due to the following two factors. First, even though the overall unemployment rate is lower in 1996 as opposed to 1980, youth unemployment rates were actually higher in 1996. Second, the overwhelming majority of criminals in our economy are employed.

Fourth, the increased inequality prevented an even larger decline in property crime. In fact, holding everything else constant, the increase in income inequality between 1980 and 1996 would have caused a 59% increase in property crime. This result is due to the fact that when income inequality increases relatively more people find it profitable to engage in criminal activities.

These results indicate that the two most important determinants of the crime rate are the apprehension probability and income inequality. The higher apprehension probability lowers the crime rate by 43% and the higher income inequality increases the crime rate by 59%. The relative magnitude of these opposing effects plays a very important role in the resulting crime rate.

The satisfactory performance of the model in accounting for the drop in crime observed between 1980 and 1996 raises an obvious question. Can the model successfully account for the behavior of the time series of property crime rates over a longer time period? Over the past quarter century the property crime rate in the United States has displayed some interesting patterns. In fact, the decline during the 1990s is only one of the interesting features of this time series. Property crime peaked in 1980, fell sharply during the first half of the 1980s, rose again during the second half of the 1980s (although not back to its 1980 level), and is currently at its lowest level in a quarter of a century. Can our analysis also account for these patterns?

The experiments we perform to answer this question can be described as follows. Take the calibrated model (which generates a crime rate equal to the one observed in 1980), and input data relative to unemployment rates, earnings profiles, age distribution of the population, shares by human capital type, the ability of the police to capture criminals, and the length of the prison term for a different year. For 1975, 1985, 1990 and 1996, compute the steady-state equilibrium of the model and compare the crime rate generated by the model to the one in the data.

The results we obtain indicate that the factors identified in our analysis as the main determinants of aggregate property crime rates can account for the behavior of the time series of property crime rates between 1975 and 1996. In particular, not only can our analysis qualitatively account for the increase in property crime rates in the 1970s, the drop observed in the first half of the 1980s, the subsequent rise in the later part of the decade and the sharp decline in the 1990s, but it can also reproduce the quantitative changes in the time series.

So far, we have focused attention on the aggregate predictions of the model. The model, however, can also generate implications with respect to individual behavior and, in particular, the composition of the criminal population. Focusing attention on the properties of the benchmark economy calibrated to 1980, our model predicts that about 79% of the people engaging in criminal activities are employed. This implies that approximately 5% (16%) of the employed (unemployed) population engages in criminal activities. This (perhaps surprising) implication of the model is consistent with the data. According to the Bureau of Justice Statistics, in 1979, 71% of all state prisoners were employed prior to their conviction. Studies by Grogger (1998) and Witte and Tauchen (1994) that use other data sets provide further evidence in support of this finding.

Next, we turn our attention to the composition of the criminal population by age and educational attainment. Our model predicts that about 76% of the people who commit property crimes are 18 years of age or younger. According to the Federal Bureau of Investigation, in 1980, 47.7% of all people arrested for property offenses were 18 years of age or younger. While the figure in the data is much lower than the one generated by the model, juvenile property offenders are often released without being formally arrested and charged of a crime. Nevertheless, we believe the model may overstate the amount of juvenile delinquency. Furthermore, the model predicted fraction of criminals without a high school diploma is equal to 46.1%. In 1979, 52.7% of the correctional population in state prisons did not have a high school diploma. Hence, the model seems to be capable of reproducing certain dimensions of the socio-demographic composition of the criminal population fairly well.

Our model also has implications on the amount of recidivism present in the economy. In our benchmark economy, 40% of all criminals had a prior conviction. This percentage is lower than the one in the data. According to the Bureau of Justice Statistics, in 1979, 61% of those admitted to state prisons were recidivists.

Hence, a possible limitation of our model is that it may overstate the amount of juvenile delinquency and understate the amount of recidivism present in the economy. In our model described above, if agents choose to commit a crime they may be apprehended and punished. The extent of punishment amounts to a prison term. However, in reality, convicted criminals may also be "stigmatized." That is, after a conviction, individuals may face lower wages than if they had not been convicted. This additional component of punishment is not legislated but occurs as a societal outcome that stigmatizes the ex-prisoner. This stigma may force the individual onto an earnings path that is lower than their pre-conviction path.

Several empirical studies have analyzed the effect of this type of stigma. Waldfogel (1994) shows the decline in earnings to be roughly 10% and quite persistent, taking eight years to get halfway back to pre-conviction levels. Allgood, Mustard and Warren (1999) find a decline of 12% and that effect did not disappear for the six years following release. Grogger (1995) and Kling (1999), on the other hand, find only a small decline that is quite temporary. Grogger (1995) finds a drop of only 4% lasting just six quarters. Kling (1999) finds an even smaller effect when looking at street criminals, but a larger effect when considering white-collar crime.

We model "stigma" as a permanent 2% reduction in wages following an incarceration. Compared to our benchmark economy without stigma, the presence of stigma induces a lower amount of juvenile delinquency (59.9 versus 76.1) and a higher amount of recidivism (75.0 versus 40.0) in the economy. These two effects are obviously related. Holding the aggregate crime rate constant, in an economy with relatively more recidivism relatively more crimes are committed by older people (the recidivists). The intuition for why stigma is associated with higher recidivism and lower juvenile delinquency is rather subtle and interesting. By essentially increasing the "severity" of punishment, stigma discourages the involvement in criminal activities. The more persistent the effect of stigma, the more severe is the relative increase in punishment for a young individual relative to an older individual. Hence, ceteris paribus, the presence of stigma discourages juvenile delinquency relatively more. In addition, stigma has a direct effect on recidivism. By reducing post-conviction wages, stigma reduces the opportunity cost of engaging in criminal activities for individuals with a criminal record. This effect generates recidivism.

Recall that in 1980, 47.7% of all people arrested for property offenses were 18 years of age or younger. Moreover, the recidivism rate among state prisoners in 1979 was equal to 61%. Thus, introducing stigma into the analysis improves the overall ability of the model to match salient features of the data.

To conclude, the results presented suggest that our analysis has identified some key factors to help further our understanding of the complex phenomenon of crime. At the same time, however, they clearly display the limitations of our current analysis and help us identify future avenues of research. In particular, a richer model is needed to confront the micro evidence on participation rates in criminal activities by different age and population groups identified by a variety of demographic characteristics. Preliminary

attempts to incorporate learning and group-specific, history-dependent apprehension probabilities in our model produced encouraging results. For example, incorporating into the model learning-by-doing in criminal activities (i.e., the more an individual engages in criminal activities the higher his returns from these activities), not only produces results that are similar to the ones induced by stigma (i.e., lower juvenile delinquency and higher recidivism than in the baseline model), but can also account for heterogeneity in participation rates by population groups. The increased flexibility, however, comes with the difficult challenge of collecting the necessary data to calibrate the additional components of the model.

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