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WHITE PAPER

Has the Presence of Smartphone Recycling Kiosks in Major U.S. Cities Affected the Incidence of Robbery and Larceny?

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Abstract

Recycling kiosks of the type offered by ecoATM allow users to exchange their smartphones and other electronic devices for cash. Some observers have suggested that the presence of these devices in a community may encourage more smartphone thefts. We have tested this hypothesis using a widely accepted statistical process known as multiple regression analysis. This paper describes our methodology and reports on results.

We use data from the FBI's Uniform Crime Reporting program on the number of robberies and larceny-thefts in the 50 most populous U.S. cities during the period from 2009 through 2013. We supplement the FBI data with Census Bureau data on the demographic and socioeconomic makeup of the metropolitan areas where these cities are located. We then analyze the data using a multiple regression model to determine whether the presence of recycling kiosks is correlated with higher crime rates.

The analysis provides no support for the hypothesis that the installation of ecoATM kiosks causes the rate of smartphone theft to increase. In fact, the analysis of the FBI data finds that ecoATM kiosks are associated with *lower* robbery and rates in the sample cities, although this correlation is not statistically significant.

In sum, our analysis of the FBI data finds that there is no scientifically valid reason to believe that a ban on ecoATM kiosks will cause the incidence of smartphone theft to be lower than it would be if the kiosks are welcomed to the city as a means to help reduce the burden on the city and the environment of disposing of e-waste.

Introduction

In recent years, many areas of the United States have experienced a surge in crimes involving the theft of mobile devices. According to Consumer Reports, an estimated 3.1 million mobile devices were stolen in the United States in 2013. Mobile device theft has become a significant driver of robberies in the country and internationally, playing a role in approximately 50 percent of all robberies in the cities of New York, San Francisco, and London in 2013.[1] This trend has prompted considerable debate in the media and among public officials, cellphone makers, wireless companies, and other stakeholders about how to address the problem.

Numerous theories have been voiced about the drivers of smartphone theft. Some have suggested that the increase in smartphone theft is partly due to the increasing popularity of these devices among consumers and their prevalence amongst the general public. Others point to an insatiable demand for secondhand smartphones in overseas markets, raising their value and hence the economic incentives for theft. A few observers have suggested that the presence of ecoATM kiosks, where consumers can recycle their smartphones for cash, has helped fuel smartphone thefts in nearby areas.

This paper presents an empirical analysis of the robbery and larceny-theft rates in major U.S. cities during the years from 2009 through 2013.[2] The purpose of this analysis is two-fold. First, we wish to determine if statistical evidence of a causal relationship exists between the presence of ecoATM kiosks and crime rates. Second, we consider the relationship between citywide rates of robbery and larceny-theft and various socioeconomic and demographic attributes of a particular metropolitan area. While this latter topic has been researched extensively in the criminology and economics literature, we believe it useful in light of the current public debate to revisit the issue based on the most recent data for U.S. metropolitan areas. Our analysis relies on city-level data on robberies and larceny-thefts collected annually by the FBI, in addition to Census data on demographic and socioeconomic variables.

We have received financial support for the research leading to this paper from Outerwall Inc., the publicly held parent company of ecoATM. The research design, methodology, and conclusions presented in this paper are entirely our own and should not be attributed to ecoATM or Outerwall.

The paper is organized as follows. Section 2 describes the data and regression model and presents summary statistics. Section 3 presents and reviews the estimation results. Section 4 discusses the conclusions that can be drawn from the analysis, as well as the limitations of the study. Section 5 notes the implications for public policy.

Data and Model

The FBI's Uniform Crime Reporting (UCR) Program publishes statistics biannually on crimes reported to local and state law enforcement agencies.[3] Crime statistics are broken into two main categories: violent crimes (murder, rape, robbery, and aggravated assault) and property crime (burglary, larceny-theft, motor vehicle theft, and arson). We use city-level data for the years from 2009 through 2013. Since we are interested specifically in crimes involving smartphones, we focus on two

1 Offices of the New York State Attorney General, San Francisco District Attorney, and Mayor of London (2014).

2 We would have preferred to use data on smartphone thefts, rather than data for the broader subcategories of robbery and larceny-theft, but such data is not collected by the FBI or by most law enforcement agencies. Given the high percentage of robberies that involve smartphones, we believe the FBI data we use provides a reasonable basis for testing which variables have a causal effect on smartphone thefts.

3 For more information, see the FBI's "Crime in the United States in 2012," available at: http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2012/crime-in-the-u.s.-2012/resource-pages/about-cius/about-cius

crime subcategories: robberies and larceny-thefts.[4] We limit our sample to the 50 most populated U.S. cities as of 2012. These cities, their population, and the number of robberies and larceny-thefts during the period from January to June 2013 (as reported to the FBI) are listed in Appendix A.

We use the following linear model to estimate citywide crime rates:

$$crmrte_{it} = \alpha + \beta \boldsymbol{X}_{itt} + \theta kiosk_{it} + city_{i} + \varepsilon_{it} \qquad (1)$$

where $crmrte_{it}$ is the natural logarithm of the number of robberies or larceny-thefts in city i and year t per 100,000 individuals. We model $crmrte_{it}$ as being dependent on the vector $\boldsymbol{X}_{it}$ of demographic and socioeconomic factors, including citywide levels of income inequality, unemployment, poverty, education, and residential mobility. These data are available from the U.S. Census for Metropolitan Statistical Areas.[5] To investigate whether the presence of recycling kiosks has any causal effect on the number of robberies and larceny-thefts, we include an indicator variable $kiosk_{it}$, which is equal to 1 if there was a kiosk present in the city during year t that was installed no later than June 30 of that year.[6] Using these criteria, the number of cities with kiosks in our sample is 14 for 2013, 7 for 2012, 2 for 2011, and 0 for 2010 and 2009. Finally, the term $city_i$ is included to account for any additional city-level factors affecting crime rates that do not change over time. In statistics terminology, this is known as a "fixed effect." The factors captured by this term include the city's geographic location, crime-reporting conventions, population demographics, and other historical factors that are difficult to measure and/or whose effect on crime is not modeled explicitly in our framework.[7]

The causes of criminal activity have long been of interest to economists, particularly since Becker's (1968) influential theory of the economics of illegal behavior.[8] The economic theory of crime posits that individuals allocate time between market and criminal activity by comparing the expected return from each, taking into account the likelihood and severity of punishment.[9] Other influential theories have their origins in Merton's (1938) strain theory and the social disorganization theory of Shaw and Mackay (1942).[10]

Such theories have generated a number of predictions about the relationship between criminal activity and various socioeconomic and demographic characteristics of the population. Empirical studies testing these predictions have consistently found a correlation between crime rates and variables such as income inequality, unemployment, and poverty.

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4 The UCR defines larceny-theft as the unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another. This includes thefts of bicycles, motor vehicle parts and accessories, shoplifting, pocket-picking, or the stealing of any property or article that is not taken by force and violence or by fraud. Robbery is defined as the taking or attempting to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in fear.

5 U.S. Census Bureau, American Fact Finder, available at http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

6 In other words, for a city to be considered as having a kiosk ($kiosk_{it}$ =1) in any given year, the kiosk(s) must have been present for at least six months as of December of the given year. We thereby allow for a time lag between the introduction of ecoATM kiosks in a city and the resulting effect (if any) on robbery and larceny rates.

7 In econometric terms, equation (1) is called a fixed effects regression model, cityi being the "city fixed effect." This framework allows us to control for unobserved time-invariant factors affecting crime rates that may be correlated with the other explanatory variables.

8 Becker, Gary S., "Crime and Punishment: An Economic Approach," *Journal of Political Economy* 76 (1968), 169–217.

9 Levitt, S., and T. Miles, "Economic Contributions to the Understanding of Crime," *Annual Review of Law and Social Science* (2006), 147–164.

10 Merton, R., "Social Structure and Anomie," *American Sociological Review* 3 (1938), 672–682; Shaw, C., and H. McKay, *Juvenile Delinquency and Urban Areas*, Chicago: University of Chicago Press (1942).

Other factors found to be associated with higher crime rates include high residential mobility (leading to reduced social cohesion), low educational attainment (lack of a college education), and a high proportion of individuals aged between 15 and 24.[11]

Table 1 provides summary statistics on each of the data variables used in our econometric analysis.

Table 1: Summary Statistics

50 Most Populated U.S. Cities, 2009–2013

Variable	Abbrev. Name	Mean	Std. Dev.	Minimum	Maximum
City population	Population	949,354	1,219,604	363,426	8,405,837
Number of Larceny-thefts (2012)	Larceny [1]	23,945	20,004	4,558	115,935
Number of Robberies (2012)	Robbery [1]	2,846	3,607	277	20,201
Unemployment rate	Unemployment	8.5	2.0	4.3	16.7
Median Income ($)	Income	55,221	10,233	36,015	90,737
% Below Poverty Level	Poverty	17.4	5.7	7.5	42.3
Income Inequality (Gini coefficient)	Inequality [2]	0.461	0.018	0.418	0.507
% living in current residence less than 1 year	Recently Moved	16.5	2.9	9.6	26.8
% of Aged >=25 with Bachelor's Degree	Bachelor's	20.2	3.8	10.0	28.9

[1] Summary statistics shown for robberies and larceny-thefts are based on data for the year 2012.
[2] The Gini coefficient is a commonly used measure of income inequality reported by the U.S. Census. It compares the income or wealth distribution of a population to a perfectly equal distribution, yielding a number between 0 and 1. The closer to 1, the less equal is the distribution of income or wealth.

Results

We summarize our main regression results in Table 2. There are two key takeaways from these results.

First, in both the robbery and larceny-theft regressions, the coefficient on the indicator variable for the presence of ecoATM kiosks is not statistically significant. In other words, the FBI data shows no statistical evidence of a causal relationship between the presence of ecoATMs and the crime rate. This result is robust to changes in the explanatory (X_i) variables included in the model and to changes in the functional form of the dependent and independent variables.

Moreover, the coefficient for the kiosk variable in both the robbery and the larceny-theft regressions has a *negative* sign,

11 Some more recent examples of this literature include Kelly, M., "Inequality and Crime," *Review of Economics and Statistics* 82(4) (November 2000), 530–539; Gould, E., B. Weinberg, and D. Mustard, "Crime Rates and Local Labor Market Opportunities in the United States: 1979–1997," *The Review of Economics and Statistics* 84(1) (February 2002), 45–61; Raphael, S., and R. Winter-Ebmer, "Identifying the Effect of Unemployment on Crime," *Journal of Law and Economics* 44(1) (April 2001), 259–283.

rather than a positive sign. This finding is at odds with the hypothesis that recycling kiosks are associated with higher crime rates. Because the coefficient is not statistically significant, however, the results cannot be interpreted as support for the opposite hypothesis: that the presence of kiosks is associated with lower crime rates.[12]

Table 2: Regression Results

	Robbery	Larceny-theft
Median Income	0.0232	-0.3076
	0.37	0.25
Inequality	-3.7806*	-0.0937
	1.84	1.12
Poverty	-0.0054	-0.0032
	0.00	0.00
Unemployment	-0.0100	-0.0053
	0.01	0.01
Bachelor's	-0.0544*	-0.0112
	0.03	0.01
Recently Moved	0.0125	0.0265**
	0.01	0.01
Kiosk	-0.0733	-0.0400
	0.04	0.04
Intercept	8.1015*	11.1903**
	4.12	2.66
City-Fixed Effect	Yes	Yes
Number of obs	245	241
R-squared	0.95	0.90

Dependent variables were the natural logarithm of the robbery rate and larceny-theft rate, respectively.

*Indicates significance at the 5% level
**Indicates statistical significant at the 1% level

Standard errors have been adjusted for clustering at the city level.

Second, our results demonstrate a statistically significant relationship between certain economic and demographic factors and the rates of larceny-theft and robberies in the sample cities. For robberies, we obtain a statistically significant coefficient for the percentage of the population aged 25 and older that holds a bachelor's degree. The coefficient of -0.0544 indicates that an increase of one percentage point in the proportion of individuals with a bachelor's degree is associated with a decrease of 5.3 percent in the robbery rate.[13]

12 If we were to lower the minimum threshold for statistical significance from 5% (the threshold accepted by virtually all social scientists) to 10%, the coefficient on the kiosk indicator in the robbery regression would become statistically significant, suggesting that the introduction of kiosks into a city is correlated with a 7.1% reduction in the robbery rate. While this is an intriguing possibility, we do not adopt it as a conclusion, because the kiosk coefficient is not statistically significant at the 5% confidence level.

13 This is calculated as -5.3 = (e^(-0.0544) -1)* 100.

We also obtain a statistically significant, although unexpectedly negative, coefficient on the income inequality variable (Gini). This result appears to conflict with previous findings that greater inequality is associated with higher crime rates. While the Gini coefficient is the most widely used measure of income and wealth inequality in the social sciences, there is still widespread debate as to the merits of this measure compared to alternative methods for capturing inequality.[14] Each method has its strengths and weaknesses. For example, one drawback of the Gini coefficient (and other similar measures) is that it treats income from government transfers (e.g., unemployment, disability) as being equivalent to income from salary and wages.[15]

Our results also show that residential mobility is a significant factor in explaining rates of larceny-thefts. As previously noted, this variable is defined as the percentage of the population that has changed residence in a given year, and is intended as a measure of social cohesion. The coefficient of 0.0265 indicates that an increase of one percentage point in the proportion of individuals who have moved within the past year is associated with an increase of 2.7 percent in the rate of larceny. This finding is in line with previous empirical studies, such as Kelly (2000). Higher residential mobility leads to weaker social and community ties, reducing the cost (in terms of severed social ties) of committing crimes and making it easier for criminals to be anonymous. It also makes people less willing to intervene when they witness a crime being committed.

The R-squared of 0.90 (larceny-theft) and 0.95 (robbery) implies that the two models explain approximately 90 percent and 95 percent, respectively, of the variation in crime rates across the sample cities and years.

Discussion

Our finding that the presence of ecoATM kiosks in a city does not contribute to the rate of either robbery or larceny-theft is in line with our expectations and with the economic theory of crime. Given the numerous channels available for selling used smartphones, most of which have fewer requirements for seller identification and do not routinely report transactions to law enforcement, we would not expect the presence of ecoATM kiosks to impact the incentives for criminal behavior.

The results of our analysis confirm that socioeconomic, demographic, and other characteristics at the city level are significant determinants of larceny-theft and robbery rates. This includes factors such as residents' educational attainment and residential mobility, as well as various unobserved variables such as crime reporting conventions and historical attitudes toward crime. Together, these variables explain at least 90 percent of the variation in crime rates across the 50 largest U.S. cities.

We readily acknowledge that our analysis of the FBI's data does not *prove* that the presence of kiosks in a city have no causal effect on smartphone thefts. No empirical study could achieve such a result. What our analysis demonstrates, however, is that the FBI data provide no support for the hypothesis that the presence of an ecoATM kiosk in a city leads to more smartphone thefts. In fact, the FBI's data suggests that ecoATM kiosks are associated with lower—not higher—robbery rates.

Policy Implications

Our analysis of the FBI data on robberies and larceny-thefts provides no support for the hypothesis that a ban on ecoATM kiosks would cause the incidence of cellphone theft to be lower than it would be if the kiosks were welcomed to the city as a means to help reduce the burden on the city and the environment of disposing of e-waste.

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14 See for example, Berube, A., "All Cities Are Not Created Unequal," Brookings Institution (February 20, 2014).

15 For further discussion on this topic, see for example, Morduch, J., and T. Sicular, "Rethinking Inequality Decomposition, with Evidence from Rural China," *The Economic Journal* 112(476) (January 2002), 93–106.

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Appendix A

Robberies and Larceny-thefts in the 50 Most Populated U.S. Cities

January–June 2013

City	Population (2012)	Number of Larceny-thefts	Number of Robberies	Larceny-thefts per 100,000	Robberies per 100,000
New York, New York	8,344,397	54,834	8,585	657	103
Los Angeles, California	3,852,782	27,111	3,849	704	100
Chicago, Illinois	2,712,920	31,976	5,416	1,179	200
Houston, Texas	2,160,712	36,158	4,612	1,673	213
Philadelphia, Pennsylvania	1,548,647	16,989	3,522	1,097	227
Phoenix, Arizona	1,488,524	18,065	1,714	1,214	115
San Antonio, Texas	1,383,641	27,747	1,020	2,005	74
San Diego, California	1,337,029	9,579	686	716	51
Dallas, Texas	1,241,700	15,462	2,082	1,245	168
San Jose, California	982,579	6,410	524	652	53
Austin, Texas	864,407	16,334	386	1,890	45
Jacksonville, Florida	836,608	11,674	627	1,395	75
Indianapolis, Indiana	834,843	12,172	1,650	1,458	198
San Francisco, California	827,420	16,535	1,989	1,998	240
Columbus, Ohio	810,103	N/A	N/A	N/A	N/A
Fort Worth, Texas	778,084	N/A	N/A	N/A	N/A
Charlotte, North Carolina	774,442	10,524	844	1,359	109
Detroit, Michigan	698,582	8,451	2,251	1,210	322
El Paso, Texas	674,124	6,130	205	909	30
Memphis, Tennessee	654,556	12,141	1,509	1,855	231
Boston, Massachusetts	637,845	6,129	904	961	142
Seattle, Washington	634,635	9,085	712	1,432	112
Denver, Colorado	634,542	7,295	492	1,150	78
Washington, District of Columbia	633,427	N/A	N/A	N/A	N/A
Nashville, Tennessee	624,993	8,995	768	1,439	123
Baltimore, Maryland	622,417	8,761	1,769	1,408	284
Louisville-Jefferson, Kentucky	604,990	9,275	678	1,533	112
Portland, Oregon	603,026	10,496	420	1,741	70
Oklahoma, Oklahoma	599,679	9,823	556	1,638	93
Milwaukee, Wisconsin	598,402	7,622	1,429	1,274	239
Las Vegas, Nevada	596,178	13,119	1,970	2,201	330
Albuquerque, New Mexico	554,621	N/A	N/A	N/A	N/A
Tucson, Arizona	524,801	13,384	508	2,550	97
Fresno, California	505,736	6,605	470	1,306	93
Sacramento, California	475,367	5,555	614	1,169	129
Long Beach, California	468,054	3,378	588	722	126

City	Population (2012)	Number of Larceny-thefts	Number of Robberies	Larceny-thefts per 100,000	Robberies per 100,000
Kansas City, Missouri	464,299	6,944	758	1,496	163
Mesa, Arizona	451,677	4,759	236	1,054	52
Virginia Beach, Virginia	445,378	4,461	155	1,002	35
Atlanta, Georgia	443,505	8,209	1,139	1,851	257
Colorado Springs, Colorado	433,570	5,899	191	1,361	44
Omaha, Nebraska	428,850	5,649	330	1,317	77
Raleigh, North Carolina	423,338	4,258	286	1,006	68
Miami, Florida	414,221	7,392	1,037	1,785	250
Oakland, California	401,230	6,298	2,541	1,570	633
Tulsa, Oklahoma	394,349	5,996	464	1,520	118
Minneapolis, Minnesota	392,768	5,884	784	1,498	200
Cleveland, Ohio	391,294	5,118	1,612	1,308	412
Wichita, Kansas	385,316	7,218	248	1,873	64
Arlington, Texas	376,215	5,551	280	1,475	74

Sources: FBI Preliminary Semiannual Uniform Crime Report, January-June (2013); U.S. Census (n.d.)

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William G. Hamm is an economics consultant with high-level experience in both government and business. An expert on public finance, financial institutions, and mortgage finance, Dr. Hamm headed the non-partisan Legislative Analyst's Office in California, where he earned a nationwide reputation for objectivity, expertise, and credibility on public policy issues ranging from taxation to healthcare. He also spent eight years in the Executive Office of the President in Washington, DC, where he headed a division of the Office of Management and Budget responsible for analyzing the programs and budgets of the Departments of Labor and Housing and Urban Development, the Veterans Administration, and numerous other federal agencies. After leaving public service, Dr. Hamm was the executive vice president/chief operating officer of a AAA-rated $50 billion bank. He has also run a $1.5 billion loan servicing business for an S&P 500 company.

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