
Vikram Maheshri and Giovanni Mastrobuoni

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Do Security Measures Displace Crime? Theory and Evidence from Italian Bank Robberies*

Vikram Maheshri† and Giovanni Mastrobuoni‡

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Abstract

Security measures intended to deter crime may unwittingly displace it to neighboring areas, but evidence of displacement is scarce. We exploit precise information on the timing and locations of all bank robberies and security guard hirings and firings in Italy over a 10-year period to estimate the deterrence and displacement effects of guards. We find that hiring a security guard lowers the likelihood that a bank is robbed by 35-40 percent, though over half of this reduction is immediately displaced to nearby banks that are unguarded. A simple theoretical model of displacement reveals ambiguity in policies to mitigate these spillovers. Our findings suggest that policies that restrict the use of guards in sparse, rural markets and that require the use of guards in dense, urban markets could be socially beneficial.

Keywords: deterrence, displacement, spillover, policing, bank security guards

JEL classification codes: K42

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†Department of Economics, University of Houston, Email: vmaheshri@uh.edu

‡Collegio Carlo Alberto, University of Essex, and IZA, Email: giovanni.mastrobuoni@carloalberto.org
1 Introduction

Households and firms spend over a trillion dollars annually on security measures to prevent crime. Moreover, the findings of this literature are increasingly used by public and private decisionmakers to evaluate the allocation of law enforcement resources and compare the effectiveness of private security measures.

An important side effect of any criminal deterrent is its potential to displace crime. Broadly speaking, displacement is the effect of a security measure in one unit on crime in neighboring units, where “neighbors” may be defined along dimensions of time, space, or crime type, and units may be defined as individuals, firms, or broader areas. While criminal displacement should not affect an evaluation of the private benefits of deterrence, it may lead to an overestimate of the social benefits of deterrence. Unfortunately, the identification of displacement effects, while potentially important, raises multiple endogeneity and measurement issues.

First, because crime is determined in an equilibrium between potential criminals and potential targets of crime (e.g., Furlong, 1987), rational investments in crime prevention necessarily reflect the underlying propensity of crime. This may introduce selection bias in a regression of attempted crime on the security investments of neighbors since they co-exist in similar environments. Moreover, firms invest in crime prevention in response to changes to the underlying propensity for crime, which introduces issues of reverse causality.

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1In the US alone, households and firms spend nearly half a trillion dollars (Chalfin, 2013). The OECD estimates that the US accounts for 40% of spending on security by member states (The Security Economy, OECD, 2004). These private expenditures are intended to complement similarly sized public expenditures. Perhaps unsurprisingly, a large literature in the social sciences has emerged to estimate the effectiveness of these measures to deter crime. See, for example, Chalfin and McCrary (2017), Nagin (1998) and Cameron (1988) for surveys on the empirical literature on criminal deterrence.

2The criminology literature has argued that criminal spillovers can be positive or negative. On the one hand, crime displacement reduces the benefits of focused policing. On the other hand, the benefits of crime control may diffuse to nearby locations, generating additional benefits, though this might be interpreted as a broader deterrent effect. In surveys, Braga (2005) and Bowers et al. (2011) find little evidence of crime displacement and more evidence of a diffusion of benefits, though a central issue in all of these studies is that criminal perceptions are unobservable and treatment areas are subject to misspecification. A series of focused policing experiments have analyzed changes in crime levels in neighborhoods that are contiguous to treatment areas (e.g., Braga et al., 1999, Weisburd and Green, 1995).

3Spatial correlation in criminal activity gives rise to what are known as “hot spots,” small areas where crime tends to concentrate. For an overview of the criminology literature, see Braga (2001).
Second, crime is also determined in a strategic equilibrium between potential targets of crime: the vulnerability of one target is necessarily a function of the vulnerability of alternative targets. Hence investments to increase the security of a particular bank are made both in response to and are reflective of the investment decisions of other banks. To the extent that neighboring firms operate in a similar criminal environment, this has the potential to introduce multicollinearity issues. Furthermore, since banks respond to one another, this may introduce further simultaneity.

Finally, because units may not be well defined \textit{a priori}, identification of displacement effects may suffer from contamination. For instance, determining whether a police patrol on one block displaces crime to a neighboring, unpatrolled block is complicated by the fact that the patrol may indirectly deter crime on the neighboring block.\footnote{As Barr and Pease (1990) point out, it is difficult to estimate displacement even in a controlled experimental setting. Before starting a trial, researchers must take a stand on the spatial nature of deterrence: if criminals perceive policing to be larger not just in treatment areas but also in control areas, then estimates of displacement will suffer from contamination. Moreover, “some displaced crime will probably fall outside the areas and types of crime being studied or be so dispersed as to be masked by background variation” (p. 293).} All of these issues are further compounded by the fact that crime data often suffer from measurement error.

In this paper, we identify displacement effects in a unique institutional setting with a geographically detailed data panel data set that allows us to circumvent the empirical issues highlighted above. Specifically, we estimate the extent to which hired security guards in Italian banks displace robberies to neighboring bank branches. This is a rich criminal context, as bank robberies are exceedingly common in Italy (the average bank faces a 7% risk of attempted robbery in a given year). Using complete information on the robbery histories and installed security measures of all registered Italian banks from 2000-2009, we find that the hiring of a dedicated guard reduces the probability of a bank robbery between 2.7 and 4.4 percentage points (31 to 50 percent). However, this private deterrent effect is substantially offset as robberies are displaced to nearby, unguarded banks: half of the robberies deterred at guarded banks will spillover to a nearby unguarded bank. No spillovers
are found to affect nearby, guarded banks.

Since hiring guards generates a negative externality on other banks, one might presume that a policy that dissuades hiring would be welfare improving. However, we show with a simple theoretical model that it is ambiguous \textit{a priori} whether policy should dissuade or promote the use of criminal deterre nts when they displace crime. Underlying this counter-intuitive result is the fact that crime may be displaced differentially across agents depending on their deterrence choices. Because of this, agents may face a coordination game with multiple equilibria when investing in deterre nts.

Given this ambiguity, two broad types of regulations could be deployed to combat displacement externalities: price regulations - a tax or subsidy on security investments - or quantity regulations - either requiring security investments in all banks or restricting security investments in all banks. Because we find that crime is displaced entirely to unguarded banks, this suggests that the negative spillovers arise entirely due to miscoordination in the hiring decisions of neighboring banks. Hence, quantity regulations that drive investment decisions to a corner solution are well suited to facilitating coordination (and mitigating displacement) as opposed to price regulations that are most effective at interior solutions.

With this in mind, we conduct simulation exercises to identify banking markets that are attractive candidates for policies that promote the hiring of guards and banking markets that are attractive candidates for policies that dissuade the hiring of guards. We find that hiring guards is unlikely to generate a social surplus in most of the country; however, guard requirements in certain densely populated urban areas may be socially beneficial. Moreover, we show that large multi-branch banks could reduce their exposure to bank robberies by reallocating their guards across different branches.

Although we study the use of private security guards, our results contribute to the broader economic literature that estimates the effect of policing on crime. A number of studies have exploited plausibly exogenous, localized and persistent
increases in police guards stemming from terrorist attacks to estimate these effects.\footnote{see, e.g., Di Tella and Schargrodsky (2004), Klick and Tabarrok (2005), Draca et al. (2011).} Our setting is well suited to the estimation of potential displacement effects, which is often lacking in those analyses that rely on broader shocks. When it comes to public security measures, Di Tella and Schargrodsky (2004) find that car thefts drop on blocks where police officers have been assigned to guard specific buildings, but they find little evidence of an increase in car thefts in unprotected blocks.\footnote{Donohue et al. (2013) reexamine the data, finding some evidence of displacement, though they conclude that for lack of statistical power the inferences are not firm.} In our context, private security guards are similarly salient, as they are positioned in uniform in front of bank branches during business hours.\footnote{More recent studies find lower or no deterrence effects when looking at mobile police patrols (Blanes Vidal and Mastrobuoni 2018, Weisburd 2016).} Our paper is perhaps most closely related to the few studies that have tried to estimate displacement effects of private auto-theft deterre nts. Ayres and Levitt (1998) show that car GPS-based tracking devices that are unobservable to thieves reduce motor-vehicle thefts across the board. When the devices are observable, as in Mexico, cars that are protected are less likely to be stolen but the attention of car thieves appears to be diverted towards unprotected cars (Gonzalez-Navarro 2013). Similarly, van Ours and Vollaard (2016) find negative externalities for partially observable car immobilizers.\footnote{There is also evidence of temporal displacement in marine pollution, from the day to the night when planes started to be used to monitor the North Sea for oil spills (Vollaard 2016), while Vollaard and van Ours (2011) find no evidence of displacement against old homes when burglary-proof windows and doors become compulsory for new ones. But again criminals might simply move farther away than just a few blocks.}

The remainder of this paper is organized as follows. In Section 2, we present a simple model of crime prevention that describes the strategic relationship between the security investment decisions of different banks and we propose an empirical approach to identify deterrence and displacement effects that follows from the logic of our model. In Section 3, we describe our unique data set of Italian bank robberies and security investments. In Section 4, we present estimates of these effects. In Section 5, we use our estimates to consider how the reallocation of guards by a social planner or private banks could best lead to reductions in robberies. We conclude in Section 6.
2 A Simple Model of Deterrence and Displacement

Our starting point is a model of crime prevention that delineates the roles of deterrence and displacement effects. It is intentionally simple and stylized since our primary goal is to explore the strategic interactions between banks that arise with displacement. This also provides a conceptual basis for the endogeneity problems in estimating criminal deterrence and displacement effects, so it is a useful starting point for our empirical analysis.

Banks \( i = 1, 2, \ldots, N \) operate in a single market, which is defined as the set of banks that are viewed as substitutes from the perspective of potential bank robbers. Each bank chooses whether or not to hire a guard, which we denote as \( g_i \in \{0, 1\} \) respectively. The cost of hiring a guard, \( c_i > 0 \), and the expected loss to \( i \) in the event of robbery, \( L_i > 0 \) may both vary by bank.

Each bank faces a probability of being robbed \( p(g_i, g_{-i}) \), where \( g_{-i} \) is the number of neighboring banks to \( i \) that hire guards. This specification of the probability of being robbed is quite flexible, as it flexibly accommodates both deterrence and displacement effects. We posit that

\[
\begin{align*}
  p(0, g_{-i}) - p(1, g_{-i}) & \geq 0 \\
  \frac{\partial p}{\partial g_{-i}} & \geq 0 \\
  \frac{\partial p}{\partial g_{-i}} \bigg|_{g_i=0} - \frac{\partial p}{\partial g_{-i}} \bigg|_{g_i=1} & \geq 0
\end{align*}
\]

Equation (1) encapsulates the deterrent effect, and equation (2) encapsulates the displacement effect. Equation (3) reflects the extent to which crime is differentially displaced to unguarded banks versus guarded banks.

Putting this all together, bank \( i \) will hire a guard if its expected loss with \( \ldots \)

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\footnote{A theoretical literature on deterrence (and sometimes displacement) incorporates complexities such as dynamic considerations (Sahl (1991), labor market considerations (Burdett et al., 2004, Clotfelter, 1977), and time inconsistency (Lee and McCrary, 2009). In a more data-driven study Amodio (2017) shows that households’ investments in burglary protection depend on the investments of their neighbors.}
guard, including the hiring cost, is less than its expected loss without a guard, or

\[ p(1, g_{-i})L_i + c_i < p(0, g_{-i})L_i \]  \hspace{1cm} (4)

We can rewrite this hiring condition to better highlight the strategic interactions of banks as

\[ \frac{p(0, g_{-i}) - p(1, g_{-i})}{\pi(g_{-i})} > \frac{c_i}{\lambda_i} \]  \hspace{1cm} (5)

The left hand side can be thought of as the marginal benefit of hiring a guard in units of expected robberies. We refer to this as the guard premium, which can be specified as a function of a single argument \( \pi(g_{-i}) \) and is equivalent to the ability of a guard to deter crime, given market conditions (see equation (1)). The right hand side can be thought of as the marginal cost of hiring a guard expressed in units of expected robberies, which we specify with a single parameter \( \lambda_i \). Note that the guard premium does not directly vary with \( i \) but rather only indirectly with market level conditions (through \(-i\)) whereas the marginal cost of hiring does vary directly with \( i \). For this reason, we can order banks by their propensity to hire a guard without loss of generality as \( 0 < \lambda_1 \leq \lambda_2 \leq \cdots \leq \lambda_N \).

Within this simple framework, we derive the equilibrium decisions of all banks summarized in Proposition 1. We define an equilibrium as a set of hiring decisions by all banks such that no bank would benefit from unilaterally deviating.

**Proposition 1.** Suppose \( p \) satisfies equations (1)-(3) and exhibits a given positive level of deterrence. Define \( \lambda_{N+1} = \infty \). Then

a (No Displacement) If equation (2) holds with equality, \( \pi(g_{-i}) \equiv \pi(0) \) is a constant function, and \( e_0 \) banks in the market will hire guards in equilibrium, where \( e_0 \) uniquely satisfies \( \lambda_{e_0} < \pi(0) \) and \( \lambda_{e_0+1} \geq \pi(0) \).

b (Existence) In equilibrium, \( e \geq e_0 \) banks in the market will hire guards for any \( e \) that satisfies \( \lambda_e < \pi(e-1) \) and \( \lambda_{e+1} \geq \pi(e) \).

\(^{10}\)We ignore the trivial case where there is no deterrent effect, as no bank would hire a guard (\( c_i > 0 \)).
c (Uniqueness) \ Let i be the smallest positive number such that \( \pi(i - 1) \leq \lambda_i \) for some i. For all \( j > i \) such that \( \lambda_j < \pi(j - 1) \) then \( i - 1 \) banks may hire guards or \( j \) banks may hire guards in equilibrium.

Proof. See Appendix.

The proof of Proposition \( \square \) immediately follows from the fact that a bank \( i \) hires a guard only if all banks \( j < i \) hire guards as well. This introduces an ordering into banks’ strategies and allows equilibrium to be determined by the marginal bank that would hire a guard. The marginal bank can simply be recovered by comparing the relative positions of \( \lambda_i \) and guard premia. If multiple \( \lambda_i \) are positioned between the relevant guard premia, then displacement may allow for the existence of multiple equilibria.

We provide intuition for the results of Proposition \( \square \) in a series of diagrams. In panel (a), there is a deterrent effect but no displacement, so the guard premium for each bank does not vary with other banks’ hiring decisions. Hence, those banks whose costs are below the fixed guard premium (equal to \( \pi(0) \)) will hire guards (as shown in black) and those banks whose costs exceed it will not hire guards (as shown in gray).

In panel (b), we introduce displacement. This generates variation in the guard premium. As more guards populate the market, the guard premium increases, so now two banks find it optimal to hire guards. However, this is not the unique equilibrium: because \( \lambda_3 \) and \( \lambda_4 \) are positioned between \( \pi(2) \) and \( \pi(3) \), a coordination game has emerged between banks 3 and 4. In panel (c), we show a second equilibrium in which four banks now find it optimal to hire guards. While it is profitable for neither of these banks to hire a guard or for both of them to hire a guard, it is never profitable for only 3 to hire a guard. Finally, the degree of differential displacement does not qualitatively affect these results. Greater differential displacement will only increase the distances between \( \pi(i) \) and \( \pi(j) \) (keeping the position of \( \pi(0) \) unchanged).

Because displacement is fundamentally an externality, it is useful to compare the competitive equilibrium described in Proposition \( \square \) with the socially optimal alloc-
Figure 1: Equilibrium in Guard Hiring

(a) No Displacement, \( e_0 = 1 \)

(b) Displacement, \( e = 2 \)

(c) Displacement, \( e = 4 \)

Note: Black dots represent banks who hire guards and grey dots represent banks who do not.

The presence of guards under displacement. Given that displacement is a negative externality that is ignored by banks in the competitive equilibrium, basic intuition would suggest that an unregulated market would feature too many guards. This intuition, however, is flawed since displacement may create coordination games amongst banks. Consider the case of panels (b) and (c) in Figure 1 and suppose that the socially optimal number of guards in this market is 311. The multiplicity of competitive equilibria implies that one equilibrium will feature too many guards while the other will feature too few. We summarize this in the following proposition:

**Proposition 2.** The socially optimal number of guards in a market may be higher or lower than the number of guards that would be hired in a competitive equilibrium.

An immediate policy implication of Proposition 2 is that it is not obvious whether regulation should encourage or discourage the hiring of guards, despite the fact that they generate negative externalities. A multiplicity of equilibria arises because consecutive \( \lambda_i \) lie between the respective guard premia – intuitively, as banks become

11It is straightforward to see that this can be supported by some combination of \( c_i \)'s and \( L_i \)'s, as the number of free parameters (8) exceeds the number of constraints that pin down this set up (5).
more homogeneous (i.e., the distances between their $\lambda_i$ diminish). Indeed, we might expect this to occur quite frequently since banks hire guards from a common local market (reducing variation in $c_i$) and nearby branches, catering to similar customer bases, may hold a similar amount in reserves (reducing variation in $L_i$). Hence policy ambiguity may be the rule rather than the exception. We capture this intuition in the proposition below.

**Proposition 3. Complete Coordination.**

a. If $\pi(0) < \lambda_1$ then an equilibrium exists in which no banks hire guards.

b. If $\pi(N) > \lambda_N$ then an equilibrium exists in which all banks hire guards.

Proposition 3 states that a complete coordination game among banks will arise when banks are similar ($\lambda_1$ is not too different from $\lambda_N$), deterrence is relatively low ($\pi(0)$ is small) and displacement is relatively high ($\pi(N)$ is very different from $\gamma_N$). We use intentionally vague terms to describe these conditions because many combinations of market characteristics may sustain multiple equilibria and policy ambiguity.

Finally, we should note that standard policies that are used to correct externalities may offer very different performance in this setting. Price regulations, such as Pigouvian taxes or subsidies, can be easily incorporated into the model as they operate entirely through $c_i$. For instance, a tax will shift the locations of all $\lambda_i$ to the left. While that effectively decreases the “value proposition” of deterrence by strengthening the first condition of Proposition 3, it weakens the second condition of Proposition 3 and only increases the dispersion of the $\lambda_i$ to the extent that the $L_i$ vary. Hence, taxes may be ill suited to “fix” the conditions underlying coordination problems between banks. On the other hand, quantity regulations, such as guard requirements or restrictions can eliminate the coordination problem entirely by forcing all banks to a particular equilibrium. Of course these may be less attractive when a market does not suffer from complete coordination problems.
3 Data

We have been granted access to the yearly Census of Bank Branches collected by the Italian Banking Association (Associazione Bancaria Italiana) between 2000 and 2009. We observe the precise location (latitude and longitude) of each bank, which allows us to assign them to markets of varying size. Branch managers are required to inform the ABI's research center on crime against banks (OSSIF\textsuperscript{12}) whenever their branch is victim of a crime. For each branch, we observe a full history of all attempted robberies. The Census also contains a full history of investments in 37 distinct security measures. These include most importantly the hiring of guards in addition to the installation of deterrents such as bulletproof glass, security vestibules, time locks, etc.

![Distribution of Robberies](image1.png) ![Distribution of Guards](image2.png)

Figure 2: Geographic Distribution of Banks, Guards, and Robberies

Notes: Each red dot represents a bank branch. The black dots in the left panel represent banks that have been victimized from 2000 and 2009 and in the right panel represent banks with security guards.

As shown in Figure 2, the spatial distribution of banks in Italy generally follows

\textsuperscript{12}Website: www.OSSIF.it
the spatial distribution of population and economic activity. Distinct clusters correspond to major metropolitan areas, and there is greater bank density in the wealthier North. Robberies are also clustered in major cities though they occur throughout the country. The distribution of security guards mimics the distribution of robberies, which portends a number of the endogeneity issues in identifying displacement that we previously raised.

Summary statistics of our sample are presented in Table 1.

Table 1: Summary statistics

<table>
<thead>
<tr>
<th>Panel A: Whole Sample, N=245,712</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Robberies</td>
</tr>
<tr>
<td>Guard</td>
</tr>
<tr>
<td>Number of Security Devices</td>
</tr>
<tr>
<td>No substitute branches in the 500m markets</td>
</tr>
<tr>
<td>No substitute branches in the 50km markets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Provinces with Below Median Robberies, N=125,401</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Robberies</td>
</tr>
<tr>
<td>Guard</td>
</tr>
<tr>
<td>Number of Security Devices</td>
</tr>
<tr>
<td>No substitute branches in the 500m markets</td>
</tr>
<tr>
<td>No substitute branches in the 50km markets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: Provinces with Above Median Robberies, N=120,311</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Robberies</td>
</tr>
<tr>
<td>Guard</td>
</tr>
<tr>
<td>Number of Security Devices</td>
</tr>
<tr>
<td>No substitute branches in the 500m markets</td>
</tr>
<tr>
<td>No substitute branches in the 50km markets</td>
</tr>
</tbody>
</table>

On average, bank branches risk 0.07 robberies per year, and 8 percent of them hire security guards. When focusing on provinces with a below-median number of attempted robberies the numbers drop to 0.04 and 0.04, respectively, while they increase to 0.10 and 0.13 in provinces with an above-median number of attempted robberies. When assigning bank branches to 500m by 500m squares, about 40 percent have no neighboring banks. When the market size increases to 50km by 50km, almost all bank branches have neighboring banks.

The spatial distribution of the hiring and firing of security guards that gives rise
to longitudinal variation in the use of security guards is shown in Figure 3. It is fairly clear that firings are more common than hirings, which is consistent with the banks trying to disinvest in security guards.

![Distribution of Hiring of Guards](image1)

![Distribution of Firing of Guards](image2)

**Figure 3: Geographic Distribution of Hiring and Firing of Security Guards**

Notes: Each red dot represents a bank branch. The black dots in the left panel represent the hiring of security guards, the ones in the right panel represent the firing of security guards.

Finally, we present raw evidence that banks' security investments are highly correlated and increasingly so over time. In the first panel of Figure 4 we present the fraction of bank pairs that have made the same guard hiring decisions in each year. As a baseline, we also plot the likelihood that just by chance two banks made the same investment decision.\(^{13}\) For each bank, we locate its nearest neighbor and compare their hiring decisions. Banks tend to behave similarly, and this behavior is increasing over time. While these facts are consistent with displacement effects generating coordination games between banks, they may simply reflect the fact that neighboring banks share a common environment. Hence, we should not conclude that displacement effects exist from this observation alone.

\(^{13}\) If \(p_t\) is the fraction of banks with guards in a given year, such number is \(p_t^2 + (1 - p_t)^2\)
In the second panel of Figure 4, we restrict our attention to bank pairs in which at least one of the banks has hired a guard. In 2000, over 40% of all bank pairs featured both banks with guards. Given that 20% percent of banks in 2000 hired a guard, we would expect only 20% of bank pairs to both hire guards if hiring was truly random. Although the use of guards declined over the sample period, the gap between observed coordination and a random baseline remained large (approximately twenty percentage points) and persistent. This is also suggestive, though not dispositive, of coordinated behavior.

4 Empirical Approach and Results

Following equations (1)-(3), deterrence and displacement are features of the function $p$. Our data presents a unique opportunity to estimate this function directly. For bank $i$ in market $j$ observed in year $t$, we specify the regression equation

$$ r_{ijt} = \beta_1 g_{ijt} + \beta_2 g_{-ijt} + \beta_3 g_{ijt} g_{-ijt} + \epsilon_{ijt} $$

where $r_{ijt}$ is a dummy variable equal to 1 if a robbery attempt was made on bank $i$ in year $t$, $g_{ijt}$ is a dummy variable equal to 1 if bank $i$ had a guard in period $t$, and $g_{-ijt}$ is equal to the fraction of banks in market $j$ (other than $i$) that were guarded in period $t$.\(^{14}\) It follows that $\beta_1$ can be interpreted as the deterrent effect, \(^{14}\)We specify $g_{-ijt}$ as a fraction instead of number in order to estimate a displacement effect that is
\( \beta_2 \) can be interpreted as the displacement effect, and \( \beta_3 \) can be interpreted as the degree of differential displacement between guarded and unguarded banks.

Consistent estimates of these effects is complicated by the fact that unobservable determinants of robbery in the error term, \( \epsilon_{ijt} \), are certainly correlated to the hiring decision of bank \( i \). Indeed, the guard hiring condition (equation (4)) features \( p \) prominently. Moreover, these unobservables should be correlated to the hiring decisions of other banks in the market.

The fact that banks strategically make decisions in a common environment introduces yet another source of endogeneity into equation (6). Because \( g_{-i} \) enters directly into equation (4), each bank’s hiring condition is implicitly a function of it’s neighbors’ hiring conditions as well. Hence, not only are unobserved environmental factors subsumed in \( L_i \) and \( p_i \) potential sources of endogeneity, but those factors subsumed in \( L_{-i} \) and \( p_{-i} \) are as well. In the language of [Manski (1993)], the displacement effects \( \beta_2 \) and \( \beta_3 \) correspond to correlated effects. These effects are difficult to disentangle from the factors that led that competitor to hire the guard in the first place, as \( i \)’s expectations over these factors enter into \( i \)’s strategic hiring decision. We attempt to identify these effects by exploiting the panel structure of our data along three dimensions: across banks, across markets, and over time.

First, we note that banks are clearly located in markets of varying sizes (see Figure 2), yet there is no a priori correct definition of a market. By properly defining a market and controlling for market specific characteristics, we may be able to control for confounders related to the common environment shared by banks. To do so, we group banks into markets indexed by \( j \), where markets are defined by subdividing Italy into squares of equal area bounded by latitude and longitude. We take no prior stance on the size of a market and instead conduct our analysis on squares of varying dimensions.\(^{15}\)

\(^{15}\)In order to make sure that our results were not affected by effects at the boundaries of markets, we reestimated all of our results by shifting the “grid” of markets by various amounts and found no systematic differences in our estimates. Specifically, if markets were defined as \( kk \)m by \( kk \)m, then we reestimated all of our results by shifting the grid of markets by \( k(1 + \delta) \) to the North and East for
Now, note that while the identification of the simple deterrent effect of a guard \((\beta_1)\) is subject to the same concerns as the identification of displacement effects it should not be affected by the size of the market in which a bank operates. This suggests an empirically driven approach to assessing whether we are able to control for common environmental confounders with fixed effects. Consider the following deterrence regression equation:

\[
r_{ijt} = \beta_1 g_{ijt} + \lambda_j + \lambda_{jt} + \epsilon_{ijt}
\]  

(7)

where \(\beta_1\) now represents a simple deterrent effect, \(\lambda_j\) is a market fixed effect and \(\lambda_{jt}\) is a province-year trend. As this equation is specified under successively smaller market definitions, the set of confounders encapsulated in \(\epsilon_{ijt}\) shrinks, but the simple deterrent effect should be unaffected. Hence, if estimates of \(\beta_1\) are largely unaffected by any choice of \(j\) below a certain threshold, then we might conclude that our fixed effects can successfully control for environmental confounders related to deterrence (e.g., the local propensity for crime, local labor market conditions, etc.)

We present the results of this exercise in Table 2. In specification (1), we include no market fixed effects and obtain a small and insignificant estimate of deterrence. Once we control for local conditions, we obtain statistically significant deterrence estimates of roughly 4 percentage points in specifications (2)-(9). This suggests that unobserved local conditions would bias our estimates of deterrence downward (i.e., in a more positive direction), which is consistent with our model since a higher propensity for robbery would induce banks to hire guards.

The "limiting" case of this exercise is the inclusion of bank-fixed effects \((\lambda_i)\) presented in specification (10). These estimates reflect a tradeoff between reverse causality due to measurement error and a greater ability to absorb environmental confounders. Because we only observe whether banks hired a guard by the end of the year, we may mismeasure whether a robbery was attempted on a guarded bank

\[\delta = 0.1k, 0.2k, ..., 0.9k.\]

\[\text{In all results presented, we estimate robust standard errors clustered by 5km squares. The statistical significance of all of our results is essentially unchanged if we instead cluster at the market } j \text{ level.}\]
versus an unguarded bank, leading to downward biased estimates of deterrence. In specification (10), $\beta_1$ is identified only off of variation in hiring within banks over time, so this problem may be particularly acute. Indeed, we estimate roughly half as strong a deterrence effect. In specification (11), we attempt to mitigate this tradeoff by omitting all observations in which a guard was just hired or fired (i.e., $g_{ijt} \neq g_{ijt-1}$). Doing so delivers an estimate of deterrence in line with what we estimated using market fixed effects.

Table 2: Simple Estimates of Deterrence in Successively Smaller Markets

<table>
<thead>
<tr>
<th>Market FE</th>
<th>Deterrent effect</th>
<th>SE</th>
<th>Obs</th>
<th>R-squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) None</td>
<td>-0.0043</td>
<td>0.0041</td>
<td>245,712</td>
<td>0.0051</td>
</tr>
<tr>
<td>(2) 50km</td>
<td>-0.0345***</td>
<td>0.0036</td>
<td>245,712</td>
<td>0.0239</td>
</tr>
<tr>
<td>(3) 25km</td>
<td>-0.0402***</td>
<td>0.0037</td>
<td>245,711</td>
<td>0.0303</td>
</tr>
<tr>
<td>(4) 10km</td>
<td>-0.0426***</td>
<td>0.0038</td>
<td>245,707</td>
<td>0.0418</td>
</tr>
<tr>
<td>(5) 5km</td>
<td>-0.0441***</td>
<td>0.0038</td>
<td>245,695</td>
<td>0.0568</td>
</tr>
<tr>
<td>(6) 2km</td>
<td>-0.0430***</td>
<td>0.0041</td>
<td>245,670</td>
<td>0.0829</td>
</tr>
<tr>
<td>(7) 1km</td>
<td>-0.0421***</td>
<td>0.0040</td>
<td>245,643</td>
<td>0.1061</td>
</tr>
<tr>
<td>(8) 500m</td>
<td>-0.0386***</td>
<td>0.0042</td>
<td>245,612</td>
<td>0.1329</td>
</tr>
<tr>
<td>(9) 250m</td>
<td>-0.0338***</td>
<td>0.0044</td>
<td>245,577</td>
<td>0.1590</td>
</tr>
<tr>
<td>Bank FE</td>
<td>-0.0157***</td>
<td>0.0056</td>
<td>244,742</td>
<td>0.2174</td>
</tr>
<tr>
<td>(10) All years</td>
<td>-0.0366***</td>
<td>0.0089</td>
<td>203,696</td>
<td>0.2276</td>
</tr>
<tr>
<td>(11) Excluding switching years</td>
<td>-0.0366***</td>
<td>0.0089</td>
<td>203,696</td>
<td>0.2276</td>
</tr>
</tbody>
</table>

Notes: All regressions include province-year fixed effects. Robust standard errors clustered by 5km squares in parentheses: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Importantly, all estimates in specifications (2)-(9) and (11) are precisely measured and insignificantly different from one another. We take this as evidence that these fixed effects plausibly control for environmental confounders due to deterrence. This implies that the inclusion of these fixed effects in the full regression equation

$$r_{ijt} = \beta_1 g_{ijt} + \beta_2 g_{-ijt} + \beta_3 g_{ijt} g_{-ijt} + \lambda_j + \lambda_j t + \epsilon_{ijt}$$  

will yield estimates of displacement ($\beta_2$ and $\beta_3$) that could be biased only by confounders that (1) vary over time within markets, (2) vary across markets within a province-year, and most importantly (3) are uncorrelated to confounders that also
influence the deterrent effect of a guard.

We estimate equation (8) defining markets from 50km squares down to 250m squares and present our results in Table 3. In all specifications, our estimates of deterrence \(\beta_1 + \beta_3 \cdot g_{ijt}\) are nearly identical to our estimates in Table 2, which confirms the extent to which this research design addresses the potential endogeneity due to shared environments of competitor banks.\(^{17}\) The effect of any potential confounder that varies by both time and by market will generally change as we define markets differently. The fact that all deterrence estimates are roughly constant across specifications suggests that endogeneity related to market definition, which by construction includes most confounders that release contextual effects, is controlled for.

### Table 3: Estimates of Deterrence and Displacement Effects

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable: Number of Robberies</td>
<td>Guard ( (\beta_1) )</td>
<td>-0.0348***</td>
<td>-0.0373***</td>
<td>-0.0391***</td>
<td>-0.0407***</td>
<td>-0.0382***</td>
<td>-0.0390***</td>
<td>-0.0316***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0053)</td>
<td>(0.0051)</td>
<td>(0.0048)</td>
<td>(0.0048)</td>
<td>(0.0044)</td>
<td>(0.0047)</td>
<td>(0.0043)</td>
</tr>
<tr>
<td></td>
<td>% Neighbors with Guards ( (\beta_2) )</td>
<td>0.0020</td>
<td>0.0063</td>
<td>0.0058</td>
<td>-0.0001</td>
<td>0.0109**</td>
<td>0.0181**</td>
<td>0.0169**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0221)</td>
<td>(0.0220)</td>
<td>(0.0189)</td>
<td>(0.0128)</td>
<td>(0.0091)</td>
<td>(0.0082)</td>
<td>(0.0078)</td>
</tr>
<tr>
<td></td>
<td>Guard \times % Neighbors with Guards ( (\beta_3) )</td>
<td>-0.0114</td>
<td>0.0018</td>
<td>-0.0171</td>
<td>-0.0171</td>
<td>-0.0231</td>
<td>-0.0200</td>
<td>-0.0330***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0286)</td>
<td>(0.0271)</td>
<td>(0.0231)</td>
<td>(0.0192)</td>
<td>(0.0145)</td>
<td>(0.0130)</td>
<td>(0.0129)</td>
</tr>
<tr>
<td></td>
<td>No substitutes</td>
<td>-0.0115</td>
<td>0.0017</td>
<td>0.0053</td>
<td>0.0064</td>
<td>0.0022*</td>
<td>0.0075**</td>
<td>0.0066**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.0321)</td>
<td>(0.0304)</td>
<td>(0.0064)</td>
<td>(0.0044)</td>
<td>(0.0035)</td>
<td>(0.0033)</td>
<td>(0.0031)</td>
</tr>
<tr>
<td></td>
<td>Square fixed effects</td>
<td>50km</td>
<td>25km</td>
<td>10km</td>
<td>5km</td>
<td>2km</td>
<td>1km</td>
<td>500m</td>
</tr>
<tr>
<td></td>
<td>Year fixed effects</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>Observations</td>
<td>245,712</td>
<td>245,711</td>
<td>245,707</td>
<td>245,695</td>
<td>245,670</td>
<td>245,643</td>
<td>245,612</td>
</tr>
<tr>
<td></td>
<td>R-squared</td>
<td>0.0239</td>
<td>0.0304</td>
<td>0.0138</td>
<td>0.0168</td>
<td>0.0100</td>
<td>0.0162</td>
<td>0.1330</td>
</tr>
<tr>
<td></td>
<td>(\beta_1 + \beta_3 \cdot g_{ijt})</td>
<td>-0.0147</td>
<td>-0.0085</td>
<td>-0.0405</td>
<td>-0.0420</td>
<td>-0.0198</td>
<td>-0.0382</td>
<td>-0.0305</td>
</tr>
<tr>
<td></td>
<td>p-value ((\beta_1 + \beta_3 = 0))</td>
<td>0.520</td>
<td>0.781</td>
<td>0.615</td>
<td>0.351</td>
<td>0.339</td>
<td>0.383</td>
<td>0.113</td>
</tr>
</tbody>
</table>

Note: Robust standard errors clustered by 5km squares in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

In contrast, the displacement effects that we estimate vary considerably by market definition. This is not surprising, as not all banks within a given market may be equally substitutable from the perspective of a robber, and this heterogeneity will be more stark in larger markets. In large markets, we find no evidence of displacement. However, in markets smaller than 1 km², we find displacement effects of 1.5-2 percentage points to unguarded banks \(\beta_2\). Specifically, if an unguarded bank’s neighbors hires guards, the branch is probability of being robbed will increase by

\(^{17}\) In order to use those observations for which a bank has no neighbors to estimate deterrence effects, we flag them with a dummy variable equal to 1 and present the estimated coefficient.
roughly 20%. However, we find no statistically significant displacement effects to guarded banks ($\beta_2 + \beta_3$), even in the smallest markets. This suggests that policies that incentivize all banks to make security investments will suffer less from reduced effectiveness due to negative displacement externalities.

Although the specifications in Table 3 are well suited to control for confounders related to the shared environment of banks in a market, they are less well suited to control for confounders related to a particular bank’s propensity to be targeted in a robbery attempt. Including bank fixed effects, as in specification (11) of Table 2, might address this problem, but it would also make endogeneity due to measurement error in the timing of guard hiring more acute. Moreover, our prior strategy of dropping observations when guard status switches is inapplicable here since we would not be able to define $g_{ijt}$ in a consistent manner that excluded this error.

Instead, we attempt to address this potential source of endogeneity by including a richer set of controls related to the timing of robberies. In Table 4, we present four specifications of our main regression with markets defined as 500m by 500m squares. The first specification is a pure replication of our main regression. In specification (2), we add market-specific linear time trends to more flexibly control for time varying unobservables, and our estimates are essentially unchanged. In specification (3), we control for the number of other security devices besides guards that banks have in operation, and our estimates remain unchanged. This is strong evidence in favor of our research design given that a bank’s decision to employ such devices is inextricably related to its decision to hire guards. In specification (4) we add market-specific quadratic time trends and, again, the estimates change very little. This is our preferred specification, and we present estimates of $\beta_1 - \beta_3$ with augmented controls (specification (4)) for all market sizes between 250m and 50km graphically in Appendix B. Finally, in specification (5), we include the lagged number of robberies in bank $i$ as a control in order to assess the extent to which we have addressed simultaneity issues. Our estimate of $\beta_3$ is slightly reduced, and we can no longer precisely estimate a differential displacement effect on this smaller
sample.

Table 4: Deterrence and Displacement Effects with Additional Controls

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variable: Number of Robberies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guard ($\beta_1$)</td>
<td>-0.0318***</td>
<td>-0.0318***</td>
<td>-0.0321***</td>
<td>-0.0350***</td>
<td>-0.0336***</td>
</tr>
<tr>
<td></td>
<td>(0.0045)</td>
<td>(0.0045)</td>
<td>(0.0045)</td>
<td>(0.0050)</td>
<td>(0.0061)</td>
</tr>
<tr>
<td>% Neighbors with Guards ($\beta_2$)</td>
<td>0.0169**</td>
<td>0.0169**</td>
<td>0.0171**</td>
<td>0.0192**</td>
<td>0.0182**</td>
</tr>
<tr>
<td></td>
<td>(0.0078)</td>
<td>(0.0078)</td>
<td>(0.0078)</td>
<td>(0.0086)</td>
<td>(0.0093)</td>
</tr>
<tr>
<td>Guard $\times$ % Neighbors with Guards ($\beta_3$)</td>
<td>-0.0336***</td>
<td>-0.0336***</td>
<td>-0.0343***</td>
<td>-0.0259*</td>
<td>-0.0209</td>
</tr>
<tr>
<td></td>
<td>(0.0119)</td>
<td>(0.0119)</td>
<td>(0.0119)</td>
<td>(0.0151)</td>
<td>(0.0184)</td>
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<tr>
<td>Number of Security Devices</td>
<td>0.0005*</td>
<td>0.0006***</td>
<td>0.0025***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td>(0.0004)</td>
<td>(0.0004)</td>
</tr>
<tr>
<td>Neighbors Average Num. of Sec. Devices</td>
<td>-0.0006*</td>
<td>0.0008*</td>
<td>0.0012**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0003)</td>
<td>(0.0004)</td>
<td>(0.0005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged Number of Robberies</td>
<td></td>
<td></td>
<td></td>
<td>-0.0473***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.0057)</td>
<td></td>
</tr>
<tr>
<td>No Substitutes</td>
<td>0.0065***</td>
<td>0.0085***</td>
<td>0.0045</td>
<td>0.0001</td>
<td>0.0119**</td>
</tr>
<tr>
<td></td>
<td>(0.0031)</td>
<td>(0.0031)</td>
<td>(0.0039)</td>
<td>(0.0054)</td>
<td>(0.0059)</td>
</tr>
<tr>
<td>Market (500m) and Year FE</td>
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<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Market specific linear time trends</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market specific quadratic time trends</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Observations</td>
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<td>245,612</td>
<td>245,612</td>
<td>245,612</td>
<td>210,702</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.1330</td>
<td>0.1330</td>
<td>0.1330</td>
<td>0.1943</td>
<td>0.2088</td>
</tr>
<tr>
<td>p-value ($\beta_2 + \beta_3 = 0$)</td>
<td>0.113</td>
<td>0.114</td>
<td>0.104</td>
<td>0.644</td>
<td>0.884</td>
</tr>
</tbody>
</table>

Note: Robust standard errors clustered by 5km squares in parentheses: *** p<0.01, ** p<0.05, * p<0.1.

To summarize, hiring a guard reduces the probability that a bank is robbed in a given year by roughly 40% off of a base of 7 percentage points. If such a bank has neighboring banks within 500m without guards, then roughly half of this reduction will be offset by robberies that are displaced to those banks. However, neighboring banks who already employ guards do not suffer any additional robberies due to displacement.

5 Displacement Policies

Displacement spillovers indicate a role for policy. The institutional characteristics of a particular market – the number of banks, likelihood and costs of robbery, and costs of guards – determine whether displacement should be addressed by an increase or a decrease in the use of guards. These characteristics are difficult to observe, but we
can use our empirical results in concert with our theoretical model to assess which markets are the most attractive candidates for different types of public and private policies.

Our parameter estimates pin down a fundamental object of our model: the guard premium. Specifically, \( \pi(0) = -\beta_1 \) and \( \pi(N) = -(\beta_1 + \beta_3) \). If hiring costs are constant across banks in a market, we can simply apply Proposition 3 to determine the range of losses \( (L_i) \) for which completely coordinated equilibria exist. Assuming an annual cost of €40 thousand for a security guard, it follows that an equilibrium with no guarded banks will exist if \( L_1 < €1.37 \) million, and an equilibrium with all guarded banks will exist if \( L_N > €662 \) thousand.

It is likely that some market exists in which every bank will face a loss of less than €1.37 million in the event of a robbery, hence an equilibrium exists in which no banks in Italy hire guards. However, this need not be the socially optimal outcome. Indeed, in certain highly urban markets, it is likely that some bank will face a loss of greater than €662 thousand in the event of a robbery; in those markets, an equilibrium with all banks hiring guards also exists.

Without detailed information on \( c_i \) and \( L_i \) for all banks, we cannot identify which equilibrium generates greater social benefits in a particular market. Instead, we consider four counterfactual scenarios to explore which markets are most likely to benefit from the use of more guards, and which markets are most likely to benefit from the use of fewer guards. We do so from the perspective of a national policymaker with the ability to enact local policies that could increase or decrease the total number of guarded banks. These policies could take the form of extreme quantity restrictions as suggested by theory, or more gentle restrictions that gradually increase or reduce the number of guards in a market.

---

\(^{18}\)According to the Italian Banking Association, banks follow the wage rules (Tariffe di Legalita’) set by the Ministry of Interior. In 2007 the hourly wage of a private security guard set by the Ministry was €24.27. With an average opening time of 7 hours for 5 days a week the yearly cost is close to €44,000.
Scenario 1: Banning Guards

The natural policy response to a negative externality would be to discourage the use of guards. Suppose banks were no longer permitted to hire guards. Then the predicted change in the number of robberies in each market would be given by

\[ \Delta r_{ijt} = \sum \left[ \beta_1 g_{ijt} + \beta_2 g_{ijt} - g_{ijt} + \beta_3 g_{ijt} g_{ijt} \right] \]

For each 500m by 500m market, we simulate the total increase in robberies that would arise from implementing such a policy in 2005 using our preferred specification. We aggregate the changes in these markets into 25km by 25km squares for visual clarity and overlay them on a map of Italy in Figure 5.

Figure 5: Simulated Increase in Robberies from Banning Security Guards

(a) Absolute Increase  
(b) Percentage Increase

Notes: Changes are simulated in 2005 using our preferred specification (column (4) of Table 4) with markets defined as 500m squares and then aggregated to the 25km by 25km level.

In the first panel, we present the absolute effects of this policy. In much of the country, banning guards would lead to no more than 5 additional robberies. However, in metropolitan areas, we might find much greater increases. For instance, Rome, Naples, Milan and Palermo would experience more than 50 additional robberies. Because this policy would mechanically have a greater effect on large population centers, we present the relative effects of this policy in percentage terms in the second panel. As before, certain more heavily populated areas (Genova, Florence, Bologna, Rome, Naples) would tend to experience greater increases in robberies.
Scenario 2: Requiring Guards

If instead all banks were required by law to hire guards, the predicted change in the number of robberies in each market would be given by

$$\Delta r_{ijt} = \sum \left[ \beta_1 (g_{ijt} - 1) + \beta_2 (g_{-ijt} - 1) + \beta_3 (g_{ijt} g_{-ijt} - 1) \right]$$

We present the effects of this policy in Figure 6. As before, we present the absolute increase in robberies from guard requirements in the first panel. Not surprisingly, the greatest reductions in robberies are concentrated in the most densely populated areas that feature the greatest number of potential targets. These include the relatively wealthy Po’ river valley in the north (which includes Milan, Turin, Bologna and Venice) along with the major cities of Rome, Naples, Bari and Florence, all of which are covered by the darkest squares. In the second panel, we instead look at the relative effects of guard requirements. In pretty much the entire country, robberies would decrease by over 75%. Of course, this does not imply that universally requiring guards is the optimal policy since hiring comes at some cost.

Figure 6: Simulated Decrease in Robberies from Requiring Security Guards

(a) Absolute Decrease

(b) Percentage Decrease

Notes: Changes are simulated in 2005 using our preferred specification (column (4) of Table 4) with markets defined as 500m squares and then aggregated to the 25km by 25km level.
Scenario 3: Gradual Removal of Guards

In the third scenario we consider a less extreme counterfactual in which we determine the net number of additional attempted robberies that would we expect if we optimally removed a single guard from a single market taking into the account that this might displace crime to other neighboring banks. We then repeat this exercise by optimally choosing a second market from which we remove a guard, then a third market, and so on.  

We present the results of this exercise in the first panel of Figure 7. As shown in the first panel, the benefits of removing guards at the margin are small – the 500 least effective guards in Italy deter fewer than 10 annual robberies altogether. However, these marginal effects do increase since successive removals creates more newly unguarded banks that are susceptible to crime that is displaced from still-guarded banks.

If we instead select markets for guard removal on the basis of losing the least expected amount to robbery instead of simply allowing the fewest number of additional robberies, we arrive at similar results. We estimate the expected cost of a robbery at a bank as the average amount stolen from all attempted robberies in that bank’s province (provincia) in a given year. As shown in the second panel of Figure 7, each removed guard increases the expected amount lost to robbers by approximately €250, though this does increases to close to €1000 at the margin.

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19 In all of our simulation exercises, we restrict ourselves to a single change per market to avoid the computational burden of an exponentially more complicated dynamic programming problem. Despite the fact that this does not necessarily yield the globally optimal reallocation of guards, we believe that it does provide useful benchmarks on the marginal values of the second, third, and so on guards who are added or subtracted.
Figure 7: Simulated Marginal Effects of Removing Guards

(a) Increase in Robberies

(b) Increase in Amount Stolen

Notes: Changes are simulated using our preferred specification on data from 2005. All amounts robbed are denominated in 2005 €.

Scenario 4: Gradual Addition of Guards

In the fourth scenario, we consider the analogous counterfactual in which we incrementally add guards to unguarded banks. As shown in Figure 8, adding guards has a small effect, as each additional guard deters approximately 0.6 robberies in expectation. Each added guard reduces the expected amount lost to robbers by approximately €1000, though this eventually declines to approximately €400.

Figure 8: Simulated Marginal Effects of Adding Guards

(a) Decrease in Robberies

(b) Decrease in Amount Stolen

Notes: Changes are simulated using our preferred specification on data from 2005. All amounts robbed are denominated in 2005 €.

Although the monetary values of a marginal guard implied by these exercises suggests that guards will not justify their salaries, we must caution that our analysis
fails to account for other external costs of robberies beyond the robbers’ haul. In particular, the perception of the added safety from guards may be valued quite highly by banks, their employees and their customers. Without knowledge of the private costs of exposure to robbery risk and the cost savings from not hiring guards, we cannot definitively identify optimal regional policies for security investments at banks.

Nevertheless, our analysis does suggest that banks in sparsely populated areas should be discouraged from hiring guards – of the small number of robberies that are deterred, a relatively large proportion will be displaced to nearby banks that are likely to be unguarded. On the other hand, large cities may want to consider encouraging the use of guards in local banks. Given the preponderance of targets and the relatively high exposure to robbery, encouraging the use of guards might generate meaningful deterrence that would not be displaced if other nearby banks were also guarded.

5.1 A Bank-level Approach

In practice, the decisions to hire and fire guards belong to individual banks. We accordingly consider an alternative counterfactual in which banks optimally relocate a guard from one of their branches to another and then compute the simulated change in robberies that would result from such a decision. While banks do not consider the spillover effects of their decisions in our simulation, the change that we simulate covers all banks and hence includes these spillover effects.

We present the results of this simulation in Figure 9. If roughly 20 banks swapped guards, each of these swaps would eliminate approximately 0.06 robberies. This reduction is primarily driven by the movement of guards from markets with many unguarded branches to markets with few unguarded branches. These moves will displace fewer robberies to unguarded branches. Of course, such markets may be rare, hence many banks with branches in fewer markets (or markets with less heterogeneous guard allocations) would generate much smaller reductions in robberies.
Notes: Changes are simulated using our preferred specification (column (3) of Table 4) with markets defined as 500m squares. Simulations are performed with data from 2005.

6 Conclusion

Understanding whether visible security measures displace or extend deterrence to nearby areas is crucial for the design of intelligent law enforcement strategies. Unfortunately, the empirical challenges in identifying and estimating such effects are fundamental and considerable. Based on a series of randomized control trials that increase policing in some well-defined areas, criminologists have embraced the idea that displacement is at most limited and that benefits from increased policing diffuse to nearby areas (see Bowers et al., 2011; Braga, 2005). However, these studies must all contend with the inescapable fact that criminal perceptions are unobservable, which requires researchers to take a stand on how criminals perceive the spatial distribution from these swaps.
of police changes. This is critically important from an empirical perspective, as mis-specifying these perceptions can easily contaminate any analysis in favor of finding diffused benefits of deterrence as opposed to displacement of crime \cite{Barr and Pease 1990}. Meanwhile, when economists have attempted to estimate deterrence effects of police patrols in quasi-experimental settings \cite{Di Tella and Schargrodsky 2004, Draca et al. 2011, Klick and Tabarrok 2005}, they have suffered from insufficient statistical power to measure potential displacement.

In this study we estimate deterrence and displacement effects of highly visible private security guards of commercial banks. In line with a game-theoretic model where banks’ strategically invest in security measures, we find robust evidence that banks respond to the hiring and firing of guards operated by nearby banks. Our unique institutional setting allows us to circumvent numerous identification threats inherent to the measurement of displacement: we observe all potential targets of crime (and hence all potential units that could experience displacement), their precise spatial relationships with each other, all relevant attempted crimes, and all strategic responses of banks to one another.

Consistent with the existing economic literature, we find that visible guards act as a substantial deterrent to potential criminals. But unlike previous studies, we find that much of this reduction in crime is deflected towards nearby bank branches: about half of attempted robberies that are deterred by a security guard are displaced to nearby, unguarded banks, but only to those that are unguarded.

Each year Italian banks spend about €200 million on security guards \cite{Mastrobuoni et al. 2010} to combat an epidemic of robberies. Our findings have immediate policy implications. The displacement effects that we find indicate a important role for the coordination of security investments by neighboring banks. Indeed, we find strong evidence that certain banks overinvest in security guards in an uncoordinated fashion. Policies that promote coordination, either by encouraging all banks to hire guards or by encouraging all banks to fire guards, could efficiently reduce the victimization of banks in the aggregate. Given Italy’s indubitable status as an out-
lier in robbery risk, such policies have the potential to generate substantial benefits to banks, consumers and law enforcement.

References


A Proofs

Lemma 1. Bank $i$ will hire a guard only if all banks $j < i$ hire guards.

Proof. We proceed by induction. Let $k$ be the smallest number such that $g_k = 0$. By construction, $k - 1$ banks hire guards, and because $g_k = 0$, $\pi(k - 1) < \lambda_k$. Therefore $\pi(k - 1) < \lambda_{k+1}$, hence $g_{k+1} = 0$. By induction, no bank $k' > k$ will hire a guard. \qed

Proof. Proof of Proposition 1

1. If equation (2) holds with equality, then $\pi(0,g_{-i}) = \pi(1,g_{-i})$ for all values of $g_{-i}$. Without loss of generality, we can call this $\pi(0)$. By inequality (5) A bank will hire a guard if and only if $\lambda_i < \pi(0)$. The claim follows from the fact that the $\lambda_i$ are weakly increasing.

2. Equation (2) implies that $\pi$ is a weakly increasing function in $g_{-i}$. The claim follows immediately from Lemma 1 and Proposition 1.1.

3. Since $\pi(i - 2) > \lambda_{i-1}$ and $\pi(i - 1) \leq \lambda_i$ by assumption, an equilibrium exists in which banks $1,...,i-1$ hire guards. Since $\lambda_j < \pi(j - 1)$, by Lemma 1 an equilibrium also exists in which banks $1,...,j$ hire guards. \qed
Figure 10: Estimates of $\beta_1$ Under Various Market Size Definitions

Notes: All controls from specification (4) of Table 4 are included. 95% confidence intervals are calculated with robust standard errors clustered by 5km squares.
Figure 11: Estimates of $\beta_2$ Under Various Market Size Definitions

Notes: All controls from specification (4) of Table 4 are included. 95% confidence intervals are calculated with robust standard errors clustered by 5km squares.
Figure 12: Estimates of $\beta_3$ Under Various Market Size Definitions

Notes: All controls from specification (4) of Table 4 are included. 95% confidence intervals are calculated with robust standard errors clustered by 5km squares.