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Victim incentives and criminal activity: Evidence from bus driver robberies in Chile

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Abstract

This paper analyzes crime as a function of the interaction between offenders and victims. I study robbery of bus drivers, a crime that remains common in cities throughout the world. Exploiting the timing of a Chilean public transportation reform and detailed administrative data, I show how victims' propensity to resist an attack can alter the level and nature of criminal activity. I also find a large decline in crime after the implementation of a technological innovation that eliminated cash transactions on buses. My results suggest a strong relationship between victim incentives, cash, and crime.

Keywords: Crime, Public transportation, Victim incentives, Cash.
JEL Classification: K42, R41.

Since the seminal work of Becker (1968), the economics of crime literature has made remarkable contributions to the understanding of the causes and consequences of criminal activity. Most empirical evaluations focus on the extent to which a particular policy deters or incapacitates potential offenders, but little attention is paid to the interactions between criminals and victims. This issue was raised as early as Cook (1979). Cook, Machin, et al. (2013) define this relationship as an endogenous bidirectional "loop" between

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victimization risk and private prevention efforts, which "has been largely neglected in the economics literature" (Cook, Machin, et al., 2013, p.10).[1] Within this framework changes in observed crime rates cannot be fully attributed to offender actions; they also depend on the interaction between offender choices and the choices made by potential victims. The degree to which potential victims undertake self-protection measures depends on the perceived risk and costs of victimization, which in turn affects the set of crime opportunities available to potential offenders.

Potential victims can alter the level and nature of criminal activity by taking a variety of actions: they can harden an attractive target, alter travel behavior to avoid certain areas or being out of the house during certain times of the day, or purchase goods and services that either reduce the likelihood of being victimized or minimize the costs associated with being victimized.[2] They can also alter an offender's original plan (e.g. an attempted theft can turn into robbery). These potential victim behaviors have not necessarily been unnoticed, but to date have received less scholarly attention, especially in empirical applications.[3]

In this paper, I analyze robberies in the Chilean public transportation system which offers a unique opportunity to understand how offenders and victims interact. The theoretical intuition underlying the results is simple. An exogenous change in victims' propensity to resist a robbery modifies not only the level of criminal activity but also its characteristics in terms of the level of violence exhibited by an offender. From a broad cost-benefit perspective, this is important since assessments of the social costs of crime based exclusively on realized offenses may hide considerable costs – namely, all protection measures adopted in order to minimize the risk of, and costs related to,

[1] Other theoretical approaches are: Cook (1986), Clotfelter (1977) and Shavell (1991).

[2] Freeman (1999) estimates that private crime prevention represents a third of the crime-control spending. By contrast, Shavell (1991) states that private expenditures on security may even exceed public expenditures.

[3] Some notable exceptions are: Cook and MacDonald (2011), Vollaard and Van Ours, 2011, Ayres and Levitt (1998) and Gonzalez-Navarro (2013).

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potential victimization.[4]

Robbery of bus drivers is a crime that remains common in cities throughout the world. For example, it was a significant problem in many United States cities in the late 1960s and early 1970s. In this case, the implementation of exact-change fare collection – along with on-board safes into which fares were dropped – has been recognized as a classic crime-prevention measure (Smith and Clarke, 2000).[5] Exact-change fare collection systems or alternative efforts to harden the target are still rare in developing countries where the public transportation sector is lightly regulated and mostly operated by informal and often privately-owned transit companies. For instance, in Santiago, the capital and by far the most populous city in Chile, fare payment using cash was the norm through 2007.

Typically, in cities where public transportation is lightly regulated, cash is the sole payment method and driver salaries are determined on a per-passenger basis that makes them accountable for protecting fare revenues. Drivers use a fare-collection box located next to them to take in cash and distribute change back to passengers. Due to the liquidity and untraceable nature of cash, the presence of this visible cash collection offers an attractive criminal opportunity commonly associated with violent incidents.

I exploit the specific timing of a major reform in the public transit system (Transantiago) that both modified driver incentives to protect fare collection boxes and subsequently eliminated the use of cash as the payment mechanism. Transantiago was implemented in Santiago, Chile, between 2005 and 2007. I use a large administrative database managed

[4]Related to how interactions between offenders and victims shape the level and nature of crime, O'Flaherty and Sethi (2008), O'Flaherty (2015), and O'Flaherty and Sethi (2010) show that perceptions about race may account for racial disparities in violent robbery and murder. More closely related to this paper, McClellan and Tekin (2017) and Cheng and Hoekstra (2013) raise concerns about the ability to increase public safety by encouraging potential victims to resist an attack, as in the case of "stand your ground" laws.

[5]The use of these devices was strongly promoted as an anti-crime tool (Gray, 1971), especially after two shootings of bus drivers in Washington D.C., and New York in May 1968. Smith and Clarke (2000) also mention a Stanford Research Institute study (1970) that reported similar results in a review of exact-change fare systems across 18 other cities.

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by the Chilean police between 2005 and 2010, capturing the Transantiago reform, to understand how victim and criminal behavior responds to changing incentives. This data allows me to identify important details of robberies such as the location, the goods stolen, and the weapon used to threaten the victim, among others.

To analyze how a change in the incentives for a victim to resist impacts the level and nature of crime, I focus on the Transantiago transition period, during which new bus companies with an alternative driver compensation structure were introduced. The implementation of Transantiago was delayed by 16 months due to technical difficulties in terms of the bus fleet and the rollout of electronic debit technology. During this interim period, bus companies were required to modify driver compensation from a proportion of fare revenue to fixed salaries. The reform thus decoupled the take-home pay of drivers from the amount of revenue (net of robberies) turned in at the end of the day. In essence this change can be described as creating a moral hazard situation between bus drivers (agent) and bus operators (principal). In this new scenario, bus drivers were less likely to adopt costly measures to protect collected fares since their income was no longer in danger. I find a large increase in cash-related robberies along with a proportional decline in the level of violence exhibited by offenders, measured as the choice between using a gun or knife in the robbery.

I finally show that robberies sharply decreased after the introduction of a simple technological innovation: the replacement of cash with a smart contactless debit card on all buses. I discuss the extent to which the change in crime could have been driven by other policies that Transantiago simultaneously implemented, as well as the extent to which this reduction spilled over into other activities with intensive use of cash. I find suggestive evidence of short-term crime displacement to places such as gas stations and

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drugstores, but I find that the magnitude of the decrease in buses is larger and likely reflects a permanent decline in crime. This finding bolsters those of Wright et al. (2014), who noted a decline in street crime following a reduction in cash transactions. Wright et al. (2014) suggest that a reduction in the use of cash is a possible explanation for the reduction in crime across a number of developed nations (Zimring, 2006; Levitt, 2004).

1 The Implementation of Transantiago

In the early 2000s, ground public transportation in Santiago, Chile, was ranked among the city's worst public services. The government subsequently decided to implement a unique modernization of the entire system. A key pillar of the reform was to integrate the underutilized subway/Metro infrastructure with a new and improved bus service. As a result, a new payment system was introduced. In addition, the driver compensation structure changed from being a proportion of daily fare revenues to a fixed amount defined independently of the number of passengers. In this section, I describe the implementation of Transantiago and the main motivations behind this policy. I focus on the aspects of the reform that plausibly affected criminal activity involving buses.[6]

1.1 Pre-reform system

The origins of the public transportation system that existed in Santiago prior to the reforms can be traced back to the Chilean dictatorship of the early 1980s, which privatized and deregulated the bus system. While some adjustments were introduced during the

[6]Transantiago was a highly ambitious plan, and after full implementation was criticized harshly by the public. For a general description of the design and implementation see Gómez-Lobo (2007), Muñoz and Gschwender (2008), Briones (2009), Muñoz, Ortúzar, and Gschwender (2009), Olavarrıa Gambi (2013), and Beltrán, Gschwender, and Palma (2013).

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1990s, the sector was only lightly regulated and the industrial organization was highly atomized. There were around 8,000 buses serving 380 routes with more than 3,000 informal operators (Muñoz, Ortúzar, and Gschwender, 2009). Perhaps the most notorious feature of the system was its lack of integration in almost every possible dimension, exemplified by the payment system. Passengers paid for their tickets with cash inside the bus. On top of having to drive the bus, drivers had to receive cash from each passenger, calculate correct change, and finally provide riders with their tickets. In addition, drivers were responsible for protecting the money collected in the so-called "Peceras" (Spanish for "fish-tank"), a responsibility that bore directly on their pay. Bus driver salaries were set proportionally to the number of passenger trips, which should be reflected by the number of tickets issued. Bus drivers had no formal contracts and they were "...expected by owners to [make] about 1/3 of their income by pocketing low "fares" charged to some passengers willing to ride without (a) ticket" (Muñoz and Gschwender, 2008). Hence, bus drivers were fully responsible for the money collected each day. Considering how bus routes were designed, this meant that drivers needed to cover on average 60km before they could drop off and tally up accumulated cash (Muñoz, Ortúzar, and Gschwender, 2009). "Peceras" were simply open boxes that allowed bus drivers to constantly sort the cash they were receiving and give change back to their passengers. Drivers often carried sticks or some other non-firearm weapon as a personal safety measure against an eventual assault.[7]

The reform effort was driven in large part by the need to modernize the system. Two main problems were identified and associated with the way that operators (bus owners) were compensated in a highly decentralized and atomized system (Gómez-Lobo, 2007):

[7] Pearlstein and Wachs (1982) report that during the 1960s, prior to the implementation of exact change policies in the United States, bus drivers carried arms while driving for self-defense purposes. Easteal and Wilson (1991) also report the use of weapons as one of the self-protection measures implemented by taxicab drivers.

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the inefficient structure of bus routes, and a phenomenon known as "the war for the fare", referring to the on-the-street competition for passengers.

The inefficient structure of bus routes was arguably a direct consequence of the lack of system integration. A single transfer doubled a passenger's costs. In order to capture market share, operators tended to privilege routes that minimized passenger transfers. Given the sprawling footprint of the city, most bus routes passed through downtown while connecting two points within the city's periphery. 80 percent of routes passed through one of the main six avenues of the city, which accentuated problems of traffic congestion and air pollution (Gómez-Lobo, 2007).

Furthermore, the on-the-street competition for passengers directly affected the quality of the service. Among the most notorious issues were passenger safety (car accidents) and discrimination against high-school students and the elderly, who paid a subsidized fare. Even more critical from a systemic point of view was that competition for passengers prevented any serious effort to coordinate buses to improve system performance. Also, given the highly atomized organization and the way operators were compensated (based on the money they collected en route), coordination even within a single bus line was extremely rare. Drivers servicing the same line competed against each other for passengers.

1.2 Transantiago

At the core of Transantiago was the idea that a more integrated system would fix many of the problems discussed above. Modernization of the bus system was a high priority, in the hope that this would increase use of multi-mode public transit (e.g. buses connecting to heavy rail), and subsequently reduce congestion, travel and wait times, and the number of car accidents (Dıaz, Gómez-Lobo, and Velasco, 2004). In addition, the government

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mandated that the system be environmentally, socially, and economically sustainable. The main features of Transantiago were defined as the following:[8]

- **New organization of the industry and new routes:** A new bus network was laid out with ten feeder and five trunk services. The city was divided into 15 zones, each of which was serviced by a single bus operator. These operating rights were franchised through an international call for tenders in 2004 and awarded to winners of the competitive bidding process. To minimize the possibility of on-the-street competition, companies were required to pay fixed salaries to bus drivers.

- **A modernized bus fleet:** Companies were required to gradually put new buses into service. Unlike the old buses, the new vehicles were equipped to service riders with disabilities and could accommodate more passengers. Since the system was in theory designed to be more efficient in terms of ridership, the original design contemplated the operation of 5,000 buses, a reduction from the 7,700 buses prior to the reform.

- **New payment system:** To promote system integration and reduce on-the-street competition, a new payment mechanism was implemented to dramatically reduce transfer costs. This mechanism was a contactless debit card (Tarjeta BIP), and all buses and the Metro were equipped with devices capable of reading these cards. BIP cards could be loaded with fare money using cash at many locations, including all Metro stations and other public spaces.[9]

[8] These three key elements were part of the proposal made within the previous PTUS plan, during the administration of President Lagos in 2002 (Ureta, 2015). The environmental goal was particularly important given the high levels of air pollution in Santiago at the time. In terms of economic sustainability, the government expressed hope that the system "... would be subsidy-free and charge an average fare similar to that of the previous system" (Muñoz, Ortúzar, and Gschwender, 2009, p.46).

[9] Prior to the implementation of Transantiago, the Metro had already implemented a non-cash payment system. BIP cards allowed passengers to cheaply transfer from buses to the Metro.

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The original plan was a simultaneous implementation of all Transantiago policies in October 2005, a few months before the presidential election. However, with the deadline fast approaching and in view of technical difficulties such as delays in the arrival of the new bus fleet and the installation of the new technological system supporting the debit cards, the government decided to postpone full implementation of the program. The government then specified that there would be a transition period, during which the new companies would go into operation using the existing bus routes and infrastructure. From a practical standpoint, this transition period would enable the government to avoid paying penalties related to delays that were stipulated in the contracts signed back in 2004, and would allow new companies to become familiar with the system by using the old routes. Five of the 15 new companies switched immediately to fixed-wage compensation for drivers (Johnson, Reiley, and Muñoz, 2015). In terms of system operation, the transition period meant no major changes for passengers except for the gradual introduction of the new buses. Services were not integrated with the Metro during this period and riders continued to pay in cash.[10]

In contrast, the final phase of the reform implementation saw changes that were substantially more significant and abrupt. The core elements of the system (new routes and fare integration between all buses and the Metro) were all implemented on a single day – February 10, 2007 – when the final stage of the Metro network expansion was complete and operators had a significant portion of the new buses available. The delay until the middle of February was intended to allow operators time to make some adjustments during the summer, which is a significantly less congested time of the year. The entire bus network began to operate along the routes of the new 15 service areas. In spite of

[10]Between 2005 and 2006, the Metro network was expanded from 45.3 to 83.8 km, but since services were not integrated bus ridership did not change substantially in this period. See Appendix Table A1 for details.

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many implementation problems, cash payments were completely eliminated from the system, and the pre-loaded BIP card was the only payment mechanism that could be used. Furthermore, by using these cards passengers were allowed to transfer from any bus to the Metro or any other bus at no or low cost.

Given the main events associated with the implementation of Transantiago, I distinguish three main periods of analysis. The pre-reform period covers the first day for which crime data is available (January 1, 2005) until the launch of the so-called transition period (October 2005). During the transition period the cash payment system was still in place and drivers started earning fixed salaries. New companies were assigned preexisting routes according to the number of buses they had, but from the customer's point of view no significant changes were apparent in the system. The post-reform period begins abruptly on February 10, 2007 when full integration between buses started and the cash payment system was replaced by the BIP card on buses. Figure 1 illustrates the timeline of events.

2 Empirical Strategy

I aim to identify the effect the Transantiago reform had on crime. I distinguish two main shocks that may have affected the overall level of crime. First, I focus on the transition period, where bus driver compensation shifts from a proportion of revenue to a fixed salary. I then analyze the effect of converting the mechanism of fare payments from cash to electronic debit cards. I propose three different but complementary strategies to estimate the effects associated with these particular periods and their surrounding circumstances. Each of the identification strategies I propose rests on alternative identifying assumptions. While each individually can be limited, I believe they collectively complement one another and that in conjunction point to a causal effect of the reforms on crime.

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2.1 Data

I combine information about the timing of Transantiago with administrative data on crimes reported to police between 2005 and 2010. The police collect information about the time and location of the crime. Importantly for the research strategy, I can observe two main features of each crime: where the crime occurred and what was stolen, if anything (cash, property, etc.).[11]

The analysis focuses on Santiago, Chile, a city with a population of approximately 6 million during this period. The data was collected and managed by the Chilean national police (*Carabineros de Chile*), which is a very centralized organization. Thus the data is almost certainly comparable across police departments over time.

I use a weekly panel of different crimes reported over 313 weeks. Table 1 compares the weekly average number of robberies reported on buses and street and public spaces. Robberies on buses represent a considerable portion of all robberies, especially given the high rate of incidents reported in Chile.[12] Table 1 shows a large increase in robberies on buses during the transition period, and a subsequent decrease in the post-reform period.

2.2 Strategy 1: Interrupted-time series of cash-related incidents on buses

Figure 2 shows the evolution of cash-related robbery incidents reported on buses. During the transition period cash-related incidents increased substantially, which coincides with the period when drivers started to be paid fixed salaries and fares were still being paid

[11] See Online Appendix Table A2. Failed robberies are displayed in Table A3, but not included in the main results because they do not report what was attemptedly stolen and are rare. There are between 0.3 and 0.67 weekly failed robberies, which represents between 1.2 and 4 percent of bus-related incidents.

[12] Chile ranked 3rd (600 robberies per 100,000 people) among 56 countries with an overall rate six times that of the United States (See UN Office on Drugs and Crime, 2014).

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with cash. By contrast, right after the launch of Transantiago (February 2007), robberies dropped dramatically, and they remained stable at a very low level for the following three years.

Based on the structure of the reform, as discussed above, I estimate the following regression:

$$Crime_t = \alpha + \beta_1 Transition_t + \beta_2 Post_t + \omega_{m(t)} + \epsilon_t \quad (1)$$

$Crime_t$ represents the number of robberies reported on buses in week t. Crime is computed by dividing the actual number of crimes during a week by the average weekly crimes reported in the pre-reform period for each specific crime category.[13] $Transition_t$ and $Post_t$ are indicator variables for whether week t corresponds to the transition period (between October 2005 and February 2010) or the post-reform period (after February 2007).[14] Finally, $\omega_{m(t)}$ is a month fixed effect.

2.3 Strategy 2: Difference in differences within buses

A reasonable concern regarding strategy 1 is the ability to rely on a counterfactual scenario defined by the pre-reform period. Without appropriately controlling for other factors coincidentally affecting cash-related robberies in the public transportation sphere, my

[13] The exact population at risk on buses is difficult to measure; doing so should consider the number of passengers riding a specific bus at a given moment. Unfortunately, temporally granular data on ridership is not available. Scholars have typically used log-crime when looking at a similar population over time. I follow (Jacob, Lefgren, and Moretti, 2007, p.17) who work with crime using overlapping jurisdictions and analyze weekly crimes "divided by the average weekly incidence in the jurisdiction during the sample period."

[14] To analyze the robustness of the coefficients, I include in some specifications $Crime_{PS(t)}$, which is the number of incidents reported in the same category of the dependent variable (whether the good involved in the crime was cash or not) on streets and in public spaces in week t. Results when including $Crime_{PS(t)}$ should be interpreted with caution, since $Crime_{PS(t)}$ itself can be seen as an outcome (Angrist and Pischke, 2008) rather than properly controlling for other factors affecting criminal activity.

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estimates would be confounded. Potential confounding factors in this context could be changes implemented in the Metro system or the bus fleet, or any other change that affected the supply of criminal activity that was not present in the pre-reform period.

In order to isolate the effect of the program from potential confounding factors, I implement a difference-in-differences (DD) approach incorporating noncash (for example, cell phones or other consumer electronics) robbery incidents in the regression. If I assume that noncash robbery incidents follow a similar pattern to that of cash robbery incidents, and that this pattern was not altered during that period for any other reason aside from the reform of driver salaries and the payment system, I can identify the effects of this reform. Figure 3 shows the evolution of both time series. During the pre-reform period, both curves show a similar pattern that motivates the use of noncash robberies as a counterfactual for how the trajectory of cash-related incidents would have evolved in the absence of the reform. Beginning with the transition period, these series move in opposite directions. Cash-related incidents increase dramatically, whereas noncash robberies remain stable. By contrast, during the post-reform period cash-related incidents drop sharply and the gap between the two curves remains remarkably stable during this entire three-year period. Notably, noncash robberies are stable throughout the three-year period, strongly suggesting that the reforms in particular impact the supply of cash-related opportunities, either through the weakening of the sentinel role played by bus drivers or the elimination of the cash boxes.

Following this logic, I propose estimating the following difference-in-differences regression:

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$$Crime_{it} = \alpha + \beta_1 Tra_t + \beta_2 Post_t + \beta_3 Cash_i + \beta_4 Cash_i \times Tra_t + \beta_5 Cash_i \times Post_t + \omega_{m(t)} + \epsilon_{it} \quad (2)$$

In this case, the dependent variable is the number of crimes reported in week t in crime category i (cash- or noncash-related incidents). Here I rely on the common trend assumption, which requires that in the absence of the policy both crime rates would have followed similar trajectories. Later, I discuss the validity of this assumption.

2.4 Strategy 3: Triple differences on buses relative to public spaces

Although the similar trajectory of cash and noncash robberies during the pre-reform period, as well as the stability of noncash robberies afterwards, supports the validity of a difference-in-differences research design, I complement the results with a third strategy as a robustness check. Valid difference-in-differences estimates require that both crime categories evolve similarly in expectation; this means that on average the proportional split between cash and noncash incidents reported on buses remained stable during the period of analysis. One potential concern might be the confounding presence of a more general trend affecting the proportion of incidents in each crime category, as compared in Figure 3. In particular, if any of the periods of analysis coincides with a trend that affected the proportion of cash- and noncash-related incidents in a broad sense, the common trend assumption could be violated. However, I can relax this assumption and still recover the parameters of interest by adopting a triple differences approach (DDD).

To motivate the triple difference approach, I rely on Figure 4, which shows the evolution of robbery incidents (cash and noncash) reported in public spaces and on streets for my

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period of analysis. As in the case of buses, it shows a seasonal pattern; the period between July and October has the highest incidence, which is consistent with how the level of regular activity rises and falls in Santiago. During the first three years, and despite the increase in noncash robberies, cash-related incidents are stable at around 150 incidents per week, eventually decreasing to 110 per week in the last year.[15] The proportional decline in cash-related incidents on streets and in public spaces suggests the presence of a major trend that may affect my estimation within buses when relying on the comparison of cash and noncash robberies. To the extent that the differences in the proportion of cash- and noncash-related incidents affected incidents in public spaces and on buses alike, I can control for these differences and identify the causal parameters. I propose a triple differences approach incorporating robberies reported on streets and in public spaces. This estimation does not require that both crime categories evolve in a similar way, but that any secular trend in the proportional split of robberies between cash and noncash incidents be similar on buses and in public spaces.

Specifically, I estimate a regression of the following form:

$$\begin{aligned} Crime_{ijt} = \alpha &+ \beta_1 Tra_t + \beta_2 Post_t + \beta_3 Cash_i + \beta_4 Cash_i \times Tra_t \\ &+ \beta_5 Cash_i \times Post_t + \beta_6 Bus_j + \beta_7 Bus_j \times Tra_t \\ &+ \beta_8 Bus_j \times Post_t + \beta_9 Bus_j \times Cash_i + \beta_{10} Tra_t \times Cash_i \times Bus_j \\ &+ \beta_{11} Post_t \times Cash_i \times Bus_j + \omega_{m(t)} + \epsilon_{ijt} \end{aligned} \tag{3}$$

[15] Figures 3 and 4 provide a sense of the frequency of incidents on buses relative to streets and public spaces. During the pre-reform period, the proportion of cash-robberies on buses (Figure 3) represents a considerable portion of the total, and is equivalent to 10 percent of the incidents reported on streets and in public spaces. Among the total robberies reported on buses, cash robberies represent a higher share, around 50 percent of the total, relative to the 25 percent share of cash robberies reported on streets and in public spaces

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In this case, i refers to the type of crime (cash or noncash), j refers to the place (bus or public spaces), and t the period associated with each observation. From this estimation, β_{10} and β_{11} represent the parameters of interest associated with the effects of modifying driver incentives and removing cash as the payment mechanism, respectively. Again, I normalized all crime categories relative to the pre-period level.

3 Empirical Estimates

In this section, I present a set of estimates associated with the effect the implementation of Transantiago had on crime. I find consistent results under the three different approaches, which I interpret as informative of the robustness of each of the research designs proposed.[16]

3.1 Interrupted time series estimates

Table 2 shows the basic coefficients using equation 1. The dependent variable is the weekly number of reported incidents divided by the average number of weekly incidents during the pre-reform period. Each coefficient represents the percentage change in crime for each period, relative to the level during the pre-period in the same crime category. In the first three columns for the noncash robbery regressions, the key coefficients are positive, but neither of them are significant. For cash robberies, however, there are large and important changes. Relative to the pre-period, the transition period had 150% more incidents, and this coefficient remains robust to the inclusion of incidents reported in public spaces as a control. On the other hand, the post-period coefficient is -0.6 which means that cash

[16]They are also consistent under other specifications, including count models (Poisson) and OLS when using log-crime as the dependent variable. See the Online Appendix Tables A4-A8 for details.

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incidents were 60% lower than in the pre-reform period. This coefficient is also robust to the inclusion of crime in public spaces as a control, which suggests that potential spillovers from buses to public spaces do not affect the magnitude of the estimates.

3.2 Difference in differences and triple differences estimates

Table 3 summarizes the coefficients I obtained from the double and triple differences regressions. Again, coefficients are very large for the transition period and imply an increase of around 130% or 150% in reported incidents. Similarly, coefficients for the post-reform period are significant but sensitive to the length of the period considered. Overall, the coefficients from Tables 2 and 3 show that my results are consistent across all specifications.

One important consideration regarding the validity of each approach is whether different crimes are independent actions, or if they are to any degree complements or substitutes. Certainly, the presence of spillovers would bias my estimates. If crimes are complements, rates of both cash and noncash crime would move together, whereas the opposite is true if they were substitutes.

If cash and noncash crimes are substitutes, during the transition period a portion of the increase in the former came from a reduction in the latter. Removing the incentives to protect the fare collection boxes on buses would have made cash much more attractive to steal, relative to other potential objects. Thus, the change in cash robberies using the time series estimates would overestimate the total effect on crime. In the case of the post-reform coefficient, the reduction in cash crimes resulted in an increase in noncash robberies that, in the absence of the reform, would have not taken place. Again, the time-series coefficients would overestimate (in absolute value) the total reduction in crime. Likewise,

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under the substitution hypothesis, the DD coefficients would exaggerate the total change in crime detected by using the interrupted time series estimates. Indeed, depending on the degree of substitution, a scenario could exist where the time-series coefficients imply a decrease in cash crime but total crime increases overall due to strong substitution towards noncash robberies.

Based on the magnitude and consistency of the coefficients, as well as the characteristics of the reforms implemented under Transantiago, I argue that any potential spillovers would account for at most a small portion of the variation captured by the estimates shown in Tables 2 and 3. Table 2, as well as Appendix Tables A4, A7, and A8, provide extensive evidence that noncash bus crimes did not change during either the transition or the post-reform period. I observe a 10-15% increase that is barely significant in only a few specifications, far from the 150% increase observed in cash robberies during the transition period. Consistently, evidence of similar spillovers can be found when comparing the difference-in-differences and time-series transition estimates, since the former are larger than the latter – suggesting that the types of crime are complements. However, the fact that during the post-reform period the difference-in-differences coefficients are slightly larger, in absolute value, could indicate that the types of crime are more likely substitutes.

Another potential source of spillover bias has to do with the degree to which crimes on buses versus streets and public spaces relate to each other. I find little evidence for such spillovers. In Table 2 I include crimes that took place in streets and public spaces as a control variable, and all the estimates are remarkably robust to the inclusion of this covariate. On the other hand, if spillovers between crimes on buses and in public spaces are important, we would expect the DD and DDD estimates to differ substantially. Note that the coefficients in Table 3 are fairly robust across specifications, and although I detect

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some differences for each period, I again cannot find consistent evidence of a specific trend that would indicate the existence of spatial spillovers. The differences between the DD and DDD transition period estimates would indicate some degree of substitution, whereas the post-reform estimates would suggest that criminal activities are spatially complementary. The lack of clear evidence for one type of spillover across time and space seems to support the idea that they cannot explain the large variation found for each relevant period.[17]

To analyze the robustness of my estimates, I reproduce the main results using municipality-level panel data. Similar to the city-level models, I use the number of robbery incidents per week divided by the weekly average level during the pre-reform period as the dependent variable. Thus, the coefficients in Table 4 can be interpreted as percentage changes and represent within-municipality estimates of the effect of the reforms introduced by Transantiago. Each panel reproduces the three main estimation methods used previously, and I include four specifications for each: weighted and unweighted regressions, as well as weekly and period-level panel data. Given that municipalities differ in terms of their pre-reform levels of bus crime, I analyze how robust the findings are to the inclusion of weights reflecting pre-period levels of cash robberies.[18]

Overall, Table 4 shows that the results are robust to the unit of analysis, being largely similar to the previous coefficients estimated at the city level. In addition, I observe the same pattern across specifications, where slightly larger transition estimates are found using the interrupted time series design, and larger (in absolute value) post-reform estimates are found using a difference-in-differences approach.

In terms of statistical inference, there is a potential concern that the standard errors

[17] It is plausible that cash and noncash robberies describe different situations: noncash robberies are likely to take place between bus passengers, while most of the cash robberies to be perpetrated against drivers.

[18] Results are similar when using alternative municipality weights, such as the average number of robberies on buses across both cash and noncash incidents.

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using weekly data would be biased due to serial correlation (Bertrand, Duflo, and Mullainathan, 2004). This can be especially problematic when using city-level data. The coefficients in Table 4 offer a solution by clustering standard errors at the municipality level. This results in larger standard errors in Table 4 than the ones obtained using city-level data. In addition, by disaggregating the data at the municipality level, I can also correct for serial correlation by collapsing the data at the period level (Bertrand, Duflo, and Mullainathan, 2004). Columns 3 and 4 in Table 4 show results at the municipality-period level. As expected, the standard errors are slightly larger but fairly stable across specifications, and even in the most conservative scenario, the coefficients remain highly significant.[19]

3.3 Discussion

Despite the large coefficients, it is possible that part of the increase could have been caused by strategic driver behavior.[20] Since bus drivers are no longer responsible for protecting fare revenue, it is possible that they strategically report false incidents to the police and simulate being robbed while keeping the collected revenue for themselves. This would also reflect a moral hazard problem induced by the new salary policy, but the policy implications would be different. Although I cannot fully rule out the possibility drivers fabricate a portion of the recorded incidents, I provide different pieces of evidence that point toward that the change in crime during the transition period being driven by an actual increase in the supply of offenses rather than drivers reporting fraudulent incidents.

[19] In Online Appendix A2 I also analyze sensitivity to outliers at the municipality level. Across all three specifications I show that the coefficients are remarkably robust to dropping a given municipality.

[20] Ideally, I would have driver-level data to test whether the transition period is associated with a change in the group composition of drivers or a behavioral change in other dimensions (e.g., route compliance). Unfortunately, data at that level are not available, especially considering the large degree of informality associated with the pre-reform system.

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Offender learning I investigate whether the evolution of incidents corresponds with a story where potential offenders learn about the drivers' new resistance strategy induced by the salary policy change. Unlike drivers, offenders cannot immediately observe the change in driver incentives to resist, but they would learn over time. Rather than a sharp change, an offender learning interpretation would require a gradual increase in robberies during the transition period. I investigate this issue by estimating an event-study model that provides a more transparent description of the temporal evolution than the previous estimates, thus allowing me to compare temporal heterogeneity within the transition period. In essence, I modify equation (2) by interacting the cash-category variable with month- or week-specific dummy variables, instead of a single indicator for each of the policy periods.

$$Crime_{it} = \alpha + \beta Cash_i + \sum_{i}^{T} \gamma_i 1[i = t] + \sum_{i}^{T} \delta_i 1[i = t] \times Cash_i + \omega_{m(t)} + \epsilon_{it} \tag{4}$$

I estimate equation 4 using both weekly and daily data. δ coefficients are identified at the monthly or weekly level, respectively.

The results displayed in Figures 5 and A2 show that the increase was gradual. There is no significant change at the beginning of the transition period, but there is a growing trend after a few months. By contrast, the set of coefficients in the post-reform period sharply decrease over time, confirming that the drop in the post-reform period was permanent.[21]

Regularity of incidents. I discuss the extent to which there is any change in the distribution of incidents during the transition period. If the increase in robberies is driven by drivers reporting fraudulent incidents, it is unlikely that they would collectively replicate the distribution of incidents from the previous period. Rather, responses should be con-

[21] See Online Appendix Figure A3, which provides a histogram of all coefficients for each relevant period.

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centrated at a particular moment of the day or on a specific day of the week (e.g., the most profitable hours). I investigate this possibility by running separate regressions at different margins, which could reveal the presence of strategic driver behavior.

First, I analyze whether the transition period is associated with notable patterns at any particular day of the week. Figure A4 shows the coefficients of interest, using different estimation methods at the city level and restricting the sample for each day of the week. The dashed blue line connects pre-reform levels of cash robberies on buses for each day of the week. The left panel shows how the transition coefficients differ by day of the week, while the right panel shows similar estimates for the post-reform period. In both panels the coefficients are fairly stable, with the exception of Saturdays, where the transition estimates are smaller. To some extent this is to be expected, given the relatively higher baseline level observed on Saturdays. Figure A5 reports similar results by comparing estimates across hours of the day. Again, results are stable across model specifications and different times of the day.

I also analyze the composition of robberies for anomalies. Table 5 reports the distribution of incidents by reported value of the stolen goods, with goods assigned to several broad categories as in the database. For each crime category and period of analysis, I calculate the *proportion of incidents* in each value bracket (Prop.Inc), as well as the proportion excluding incidents where no value was reported (Prop.Inc-V). Given that in 2005 the average fare was (CLP) $380, fare robberies usually fall within either the $10K–$50K or the $50K–$100K categories. In spite of the large increase in cash robberies from the pre-reform to the transition period, the proportion of incidents in each value category remains remarkably stable. For example, in both periods 62 percent of the incidents fell into the $10K–$50K category. These results confirm the magnitude of the effects for each

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period and provide little or no evidence that the change in incidents during the transition period was caused by fraudulent reports.

Displacement. Finally, I discuss whether there is evidence of displacement of crime towards places with intensive use of cash during the post-reform period. Figure 6 describes the evolution of cash-intensive places (CIP: local stores, supermarkets, gas stations, and drugstores) over time. If the increase in the transition period was caused by strategic driver behavior, it is unlikely that evidence of crime displacement during the post-reform period, when cash payment of fares was eliminated from buses, will be observed. Given that bus robberies can be strongly linked to the need for cash, I analyze how much of the reduction in the post-reform period is associated with an increase in CIP crime. Evidence of displacement to other targets in the post-reform period would suggest that the crime increase in the transition period was unlikely to be caused by strategic driver behavior.

Following my main specification, Figure 7 shows separate coefficients for the change in cash robberies reported in CIP and on buses during the post-reform period and relative to the transition period. On the horizontal axis I also analyze the robustness of the coefficients by modifying the number of weeks included in the post-reform period. For each sample of weeks in the post-reform period, I plotted coefficients from both the interrupted time-series and difference-in-differences estimates. Figure 7 shows that right after the beginning of the post-reform period, the magnitude of the increase in crimes in CIP was comparable to that of the decline observed on buses. This provides strong evidence of displacement to other places where cash was available. In addition, we can see that coefficients related to CIP crime decline when more weeks are included in the post-reform period, which suggests that the displacement effect fades away over time. This attenuation could be due to several factors, such as an incapacitation effect that gradually kicks in as offenders are

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arrested and not replaced or as victims adopt protective measures or otherwise change their behavior. Overall, while it is impossible to completely rule out false reporting by drivers, given the magnitude and time path of the increase, the similar distributions of reports across hours and days, and the displacement that appears to occur after exact fare technology is added, it appears that the crime increase during the transition period likely reflects an actual increase in the supply of offenses.

4 Victim Resistance and the Threat of Lethal Force

In this section, I analyze the extent to which the transition period also altered the level of violence observed. A crucial consideration is the type of weapon offenders choose to use when robbing a bus. A drastic change in drivers' propensity to resist may have also affected the weapon choices made by offenders if reform altered the chances of a successful robbery when using different weapons. For example, consider a simple case where offenders are deciding between relatively lethal weapons such as a firearm or a knife. The relative benefit from using a firearm is greater when victims are more likely to exhibit a high level of resistance. In other words, with the decline in the incentive for drivers to resist (their pay no longer depends on the outcome of the robbery) offenders will substitute towards less lethal threats (e.g. knives).

Figure 8 shows the evolution of cash robberies on buses by the kind of weapon used in the attack. We can see that all weapon incidents increased during the transition period, but the proportion of firearm-related incidents decreased. This is consistent with the prediction of smaller returns to the use of firearms. In order to empirically test whether the change in weapon choice is significant, I run the following regression:

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$$Prop.Firearm_t = \alpha + \beta_1 Transition_t + \beta_2 Post_t + \omega_{m(t)} + \epsilon_t \quad (5)$$

Table 6 shows the results for regression (5). The transition period is associated with a significant 8 percent decline in the proportion of incidents involving firearms.[22] Although this period experienced a large increase in criminal activity, most of the increase was driven by less-lethal incidents in terms of the weapon used.[23] Table 6 confirms the prediction that the increase in criminal activity associated with the change in driver incentives to resist also modified the level of violence drivers were exposed to during the transition period.[24]

Finally, Table 7 reinforces the idea of a proportional decline in violence. It compares the proportion of victims who reported some injury among those who were threatened with a particular type of weapon for each period of analysis.[25]

If bus drivers were effectively offering a lower level of resistance during the transition period there should be a decline in the proportion of victims who were injured. Although there is an increase in the number of people reporting some injury (60 percent), it is substantially lower than the overall increase in cash-related incidents (around 130 percent). Moreover, Table 7 shows that across all weapon categories the proportion of victims reporting some injury declined, and the reduction is particularly large among those associated with less lethal incidents in which bus drivers are presumably more likely

[22] This finding is consistent across other specifications. See Online Appendix Tables A11 and A12 for details.

[23] Although some post-reform coefficients are significant and similar in magnitude to the ones obtained for the transition period, they are sensitive to the length of the period. When I exclude the years 2009 and 2010 (columns three and four), the post-reform coefficients are much smaller in magnitude and no longer significant.

[24] In Online Appendix Table A13 I present results from similar regressions using noncash incidents reported on buses, and I find no significant results in terms of the weapon used.

[25] Although one might suggest looking at more extreme outcomes, such as fatalities, these are fortunately rare events in Chile. During the six-year period of analysis, there were only three homicides on buses.

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to offer resistance. To sum up, during the transition period the percentage of victims reporting some injury declined from 9 to 6 (a 30 percent decline in the likelihood of being injured). Importantly, this pattern contrasts with almost no change being observed in the proportion of noncash robbery victims who reported some injury during the same period.[26]

5 Conclusion

In this paper I describe criminal activity as the interaction between potential offenders, victims, and the environment. By exploiting features of a reform of the Santiago public transportation system, I show that potential offender behavior is shaped by the environment and what victims do, which affects both the level and characteristics of criminal activity.

There are three main empirical findings. First, during the period where driver salaries were strictly dependent on fare revenues I observe a relatively low proportion of cash-related robberies. However, cash robberies surge when drivers started to be paid fixed salaries. The magnitude of this increase is substantial and reinforces the idea that private behavior is an important omitted variable in understanding victimization.

I also find that the change in driver salary policy reduced the average level of robbery violence. This finding suggests that although victims can do a lot to avoid being victimized, it may come at a high personal cost. This is a crucial consideration with welfare implications. Reducing crime is an important goal, but so is harm reduction (Cook, 2014). This finding indicates the necessity of a broad scope for welfare considerations when evaluating

[26] In Online Appendix Table A14 I show that during that same period the proportion of noncash-related victims reporting some injury remained the same, around 11 percent.

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anti-crime policies. It also suggests caution with regard to policies that seek to reduce crime based on increasing victim propensity to resist, as such policies may also induce a substantial increase in the level of violence exhibited by offenders.

I also document an abrupt decline in crime caused by the eradication of cash transactions. In spite of the specific context –buses– it has implications for other crime settings. A decline in the use of cash in everyday life transactions has been suggested as an alternative explanation for the observed decline in crime in the United States in the last two decades. Although the effect I found is strictly local its magnitude suggests a promising area of research. In a similar way, these findings suggest a strong link between victim incentives and the characteristics of criminal activity, and future research should evaluate the extent to which these kinds of interactions can be informative in other contexts of violence. For example, relative to other crimes where the offender is unknown to the victim, the salient presence of cash as well as the ability of offenders to learn from a certain type of victim can together play a role in determining the scope of action for victim resistance, and thus this scenario may not necessarily represent other types of interactions where the target or the victim's type is less visible.

Finally, I would like to stress a final point about system regulation and some of its implications. Exact-change fare collection with on-board secure boxes as a crime-prevention tool has been the standard in the United States since the early 1970s. This kind of system was implemented following a public debate regarding security on buses and nowadays seems to be part of a basic standard in public transportation. What is striking is the fact that despite the availability of a simple and effective crime-prevention tool, open-fare collection boxes are still present in the public transportation sectors of many cities across the world. This begs the further research question regarding what

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prevents policy makers from adopting these basic safety measures. A tentative hypothesis has to do with a lack of regulation in the public transportation sector, a characterization that aptly describes the bus system in Santiago prior to the reform. If buses are simply competing in the streets to capture the largest possible number of passengers per ride, it seems plausible to believe that both agents, bus owners and drivers, have strong incentives to keep open fare collection boxes in place, even at the expense of a higher risk of violence and victimization. From a bus owner's perspective, this may encourage drivers to directly control fare evasion, a common problem in the public transportation sector. At the same time, the use of cash may allow drivers to increase their salaries by charging a lower fare to those passengers willing to ride without a ticket. A light regulation in the public transportation sector does little to incentivize the implementation of simple crime prevention measures. In this case, the final product can be the persistent presence of a highly attractive criminal opportunity.

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A Appendix

Table 1: Robberies on Buses and Public Spaces/Streets by Period

	Buses				**Street and Public Spaces**			
	Noncash		Cash		Noncash		Cash	
	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev
Pre	12.12	(0.74)	10.81	(0.69)	334.67	(6.84)	132.81	(2.88)
Transition	14.35	(0.58)	27.62	(1.40)	385.65	(7.55)	133.60	(1.68)
Post	13.65	(0.34)	3.26	(0.14)	387.16	(4.37)	116.14	(1.61)

Notes: Values are weekly averages for each period. Cash- and noncash-related incidents are classified based on the type of good stolen reported by the victim.

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Table 2: Interrupted Time Series Estimates: Robbery on Buses

	(1) Noncash	(2) Noncash	(3) Noncash	(4) Cash	(5) Cash	(6) Cash
Transition	0.184*	0.127	0.103	1.555***	1.596***	1.603***
	(0.077)	(0.066)	(0.067)	(0.143)	(0.129)	(0.126)
Post	0.126	0.071	0.0482	-0.699***	-0.701***	-0.617***
	(0.067)	(0.054)	(0.057)	(0.064)	(0.060)	(0.066)
Month FE	No	Yes	Yes	No	Yes	Yes
$Robb_{PS}$	No	No	Yes	No	No	Yes
Pre-reform Level of DV	12.12	12.12	12.12	10.81	10.81	10.81
N	313	313	313	313	313	313
R-sq	0.018	0.292	0.295	0.742	0.785	0.793

Notes: Interrupted time series coefficients estimated using equation 1. The dependent variable is the number of crimes divided by the weekly average reported in the pre-period in the same crime category indicated at the top of each column. $Robb_{PS}$ represents robberies in streets and public spaces in the same crime category (cash- or noncash-related incidents). Robust standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001. Coefficients are robust to the number of lags by including several Newey-West estimates as shown in Tables A4, A5, and A6.

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Table 3: Double and Triple Differences Estimates: Robbery on Buses

	(1) DD	(2) DD	(3) DDD	(4) DDD
Trans x Cash (x Bus)	1.371***	1.371***	1.517***	1.517***
	(0.144)	(0.142)	(0.155)	(0.154)
Post x Cash (x Bus)	-0.825***	-0.698***	-0.542***	-0.442***
	(0.079)	(0.083)	(0.090)	(0.095)
Pre-reform Level of Cash-Robbery	10.81	10.81	10.81	10.81
N	626	416	1,252	832
R-sq	0.718	0.711	0.68	0.674

Notes: Coefficients of interest for difference-in-differences (DD) and triple differences (DDD) regressions. Model specification is indicated at the top of each column, as denoted by equations 2 and 3, respectively. The dependent variable is the number of crimes divided by the weekly average reported in the pre-period in the same crime category. All regressions include month fixed effects. Columns (1) and (3) consider the full period of analysis (2005-2010), whereas columns (2) and (4) restrict the sample to the period (2005-2008). Robust standard errors in parentheses. * p<0.05, ** p<0.01, *** p<0.001

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Table 4: Coefficients using Municipality-level Panel Data

	(1)	(2)	(3)	(4)
Panel A: Interrupted Time Series				
Transition	1.692***	1.791***	1.627***	1.744***
	(0.296)	(0.346)	(0.353)	(0.417)
Post	-0.549***	-0.649***	-0.558***	-0.649***
	(0.082)	(0.042)	(0.091)	(0.061)
N	9,703	9,703	93	93
R-sq	0.097	0.177	0.694	0.736
Panel B: Difference-in-differences				
Trans x Cash	1.200**	1.522***	1.200**	1.522**
	(0.337)	(0.406)	(0.375)	(0.452)
Post x Cash	-0.981***	-0.926***	-0.981***	-0.926***
	(0.165)	(0.213)	(0.184)	(0.237)
N	18,780	18,780	180	180
R-sq	0.064	0.109	0.552	0.592
Panel C: Triple Differences				
Trans x Cash x Bus	1.375***	1.618***	1.375***	1.618***
	(0.330)	(0.390)	(0.350)	(0.413)
Post x Cash x Bus	-0.702***	-0.651**	-0.702***	-0.651**
	(0.175)	(0.201)	(0.186)	(0.213)
N	38,186	38,186	366	366
R-sq	0.056	0.098	0.502	0.557
Weights	No	Yes	No	Yes
Frequency	Weekly	Weekly	Period	Period

Notes: Coefficients estimated using weekly or period municipality-level data using 31 municipalities within the Santiago urban metropolitan area. Each panel indicates the method I use to estimate each set of coefficients. All regressions include municipality fixed effects. Weights are calculated based on the number of cash-related incidents during the pre-reform. On average, during the pre-reform period, municipalities have 0.32 (cash-related) and 0.36 (noncash-related) weekly robbery incidents. Three municipalities with unusual levels of noncash robberies on buses during the pre-reform period were excluded from the sample, but weighted results are robust to the inclusion of these three municipalities. Robust standard errors clustered at the municipality level in parentheses. * p<0.05, ** p<0.01, *** p<0.001

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Table 5: Proportion of Incidents by Period and Value of Stolen Good

Period	Pre		Transition	
Panel A: Cash	Prop.Inc	Prop.Inc-V	Prop.Inc	Prop.Inc-V
No Value	0.189		0.142	
$10k -$50k	0.509	0.628	0.535	0.624
$50k - $100k	0.203	0.250	0.243	0.283
$100k-$250k	0.079	0.098	0.060	0.070
< $250k	0.020	0.024	0.020	0.024
# Incidents/week	10.81		27.57	
Panel B: Noncash	Prop.Inc	Prop.Inc-V	Prop.Inc	Prop.Inc-V
No Value	0.438		0.373	
$10k -$50k	0.237	0.421	0.221	0.353
$50k - $100k	0.219	0.389	0.264	0.420
$100k-$250k	0.085	0.151	0.095	0.151
< $250k	0.022	0.039	0.047	0.076
# Incidents/week	12.07		14.28	

Notes: Value categories are in Chilean pesos for each period. Panel A shows the proportion of cash-related robberies in buses. Panel B shows proportions of noncash-related robberies in buses. Prop.Inc indicates the proportion of incidents in each value-period category while Prop.Inc-V indicates the proportion of incidents in each value-period category, excluding those incidents in the "No Value" category.

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Table 6: Time Series Estimates: Proportion of Firearm Incidents. Cash-Robbery on Buses

	(1)	(2)	(3)	(4)
Transition	-0.0769*	-0.0828**	-0.0769*	-0.0628*
	(0.030)	(0.028)	(0.031)	(0.028)
Post	-0.0701*	-0.0748*	-0.0413	-0.0382
	(0.034)	(0.032)	(0.040)	(0.036)
Month FE	No	Yes	No	Yes
YEAR <= 2008	No	No	No	No
Pre-reform Mean of DV	0.439	0.439	0.439	0.439
N	72	72	48	48
R-sq	0.039	0.168	0.06	0.328

Notes: Interrupted time series coefficients estimated using equation 5. The dependent variable is the monthly amount of firearm-and-cash-related incidents divided by the number of cash-related incidents reported on buses. Robust standard errors in parentheses.* p<0.05, ** p<0.01, *** p<0.001

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Table 7: Proportion of Victims with Some Injury by Weapon Used: Cash-Robbery

Period	Pre		Transition		Post	
Weapon	Prop.S.I	# [Inc/Month]	Prop.S.I	# [Inc/Month]	Prop.S.I	# [Inc/Month]
No Weapon	0.333	0.3	0.000	0.8	0.286	0.1
Firearm	0.058	17.1	0.055	38.9	0.109	4.7
Knife	0.070	18.5	0.045	58.9	0.139	6.0
Stick	0.333	0.9	0.220	2.7	0.533	0.3
Threat	0.350	2.0	0.340	3.5	0.517	1.2
Other	0.500	0.4	0.000	2.1	0.083	0.3
Total [Inc/Month]		39		107		13

Notes: Prop S.I is the *proportion* of victims who report *some injury* in each period. For display purposes, I include a column with the number of incidents per month reported in each weapon category for each period.

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Figure 1: Timeline of the Events: Pre-reform, Transition, and Post-reform Periods

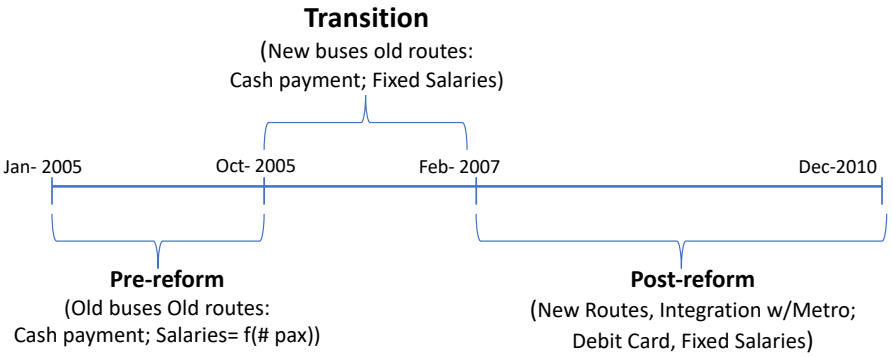

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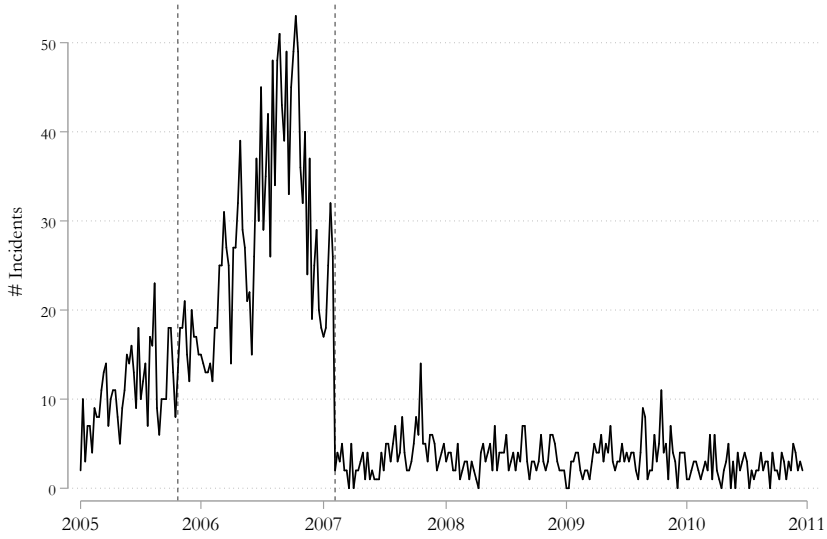
Figure 2: Cash-related Robbery Incidents on Buses



Notes: Lines connect weekly incidents. Vertical dashed lines show the beginning of the transition (October, 2005) and the post-reform (February, 2007) periods.

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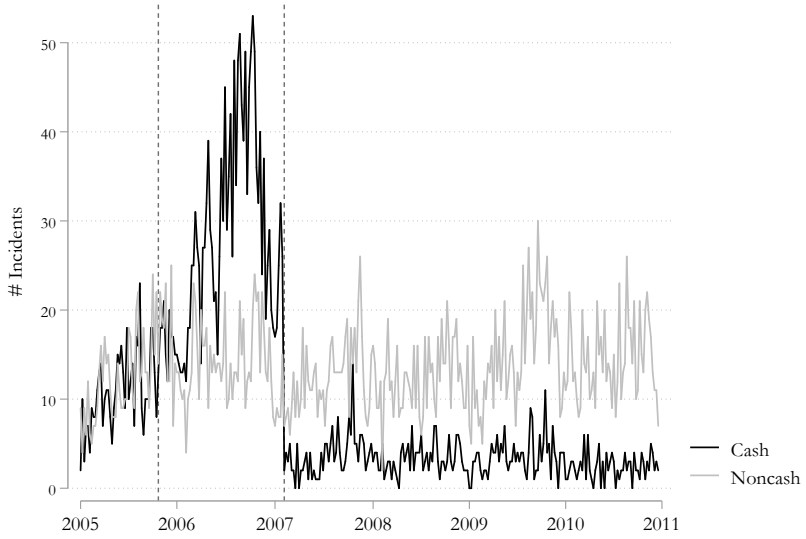
Figure 3: Robbery Incidents on Buses



Notes: Lines connect weekly incidents in each crime category. The black line connects cash robberies while the gray line represents the evolution of noncash robberies. Vertical dashed lines show the beginning of the transition (October, 2005) and the post-reform (February, 2007) periods.

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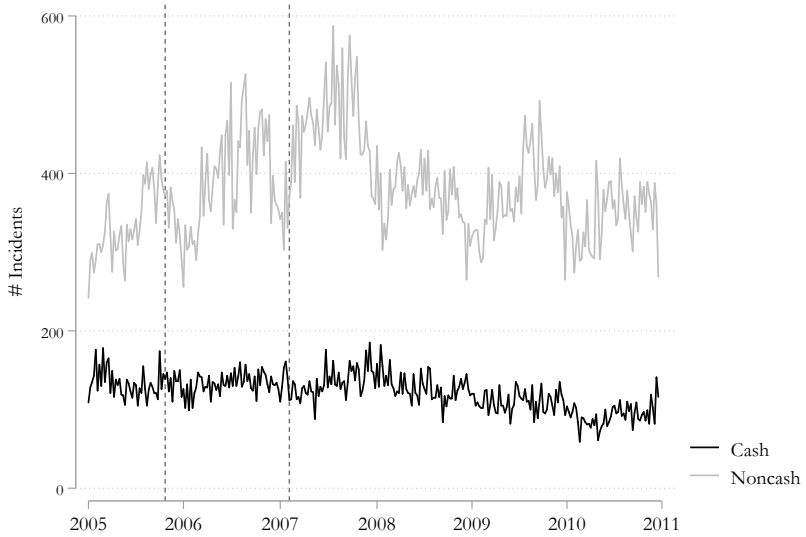
Figure 4: Robbery Incidents on Streets and in Public Spaces



Notes: Lines connect weekly incidents on each crime category. The black line connects cash robberies while the gray line represents the evolution of noncash robberies reported in streets and public spaces. Vertical dashed lines show the beginning of the transition (October, 2005) and the post-reform (February, 2007) periods.

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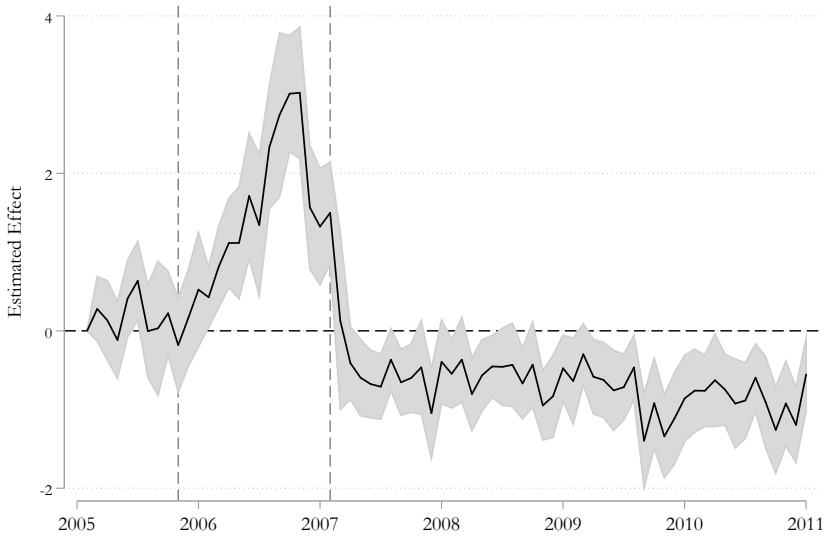
Figure 5: Event-Study: Monthly Evolution of Cash-Robberies



Notes: The line represents the evolution of the interacted coefficients δ from equation (4). This represents the monthly effect of the reform on cash robberies reported on buses. The gray area around the line represents the 95 percent confidence interval associated with each monthly coefficient. Vertical dashed lines show the beginning of the transition (October, 2005) and the post-reform (February, 2007) periods.

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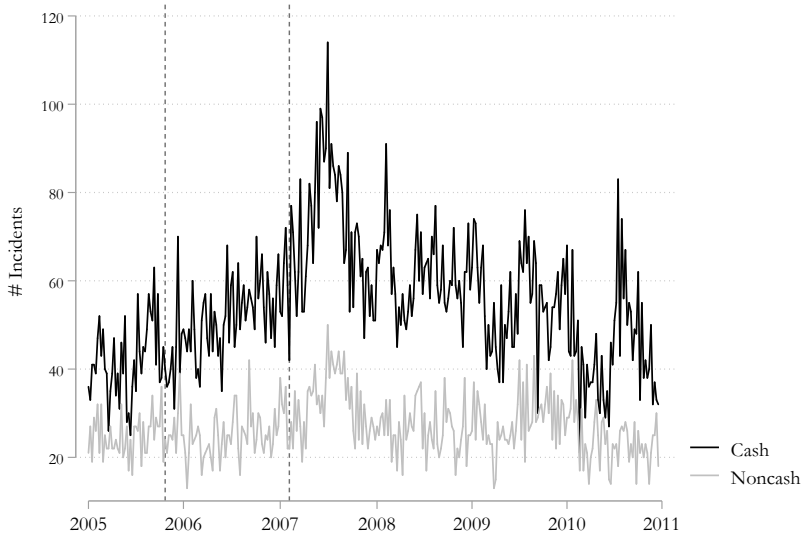
Figure 6: Robbery Incidents in Cash-intensive Places (CIP)



Notes: Lines connect weekly incidents reported in local stores, supermarkets, gas stations and drugstores for each crime category (cash- and noncash-related robberies). Vertical dashed lines show the beginning of the transition (October, 2005) and post-reform (February, 2007) periods.

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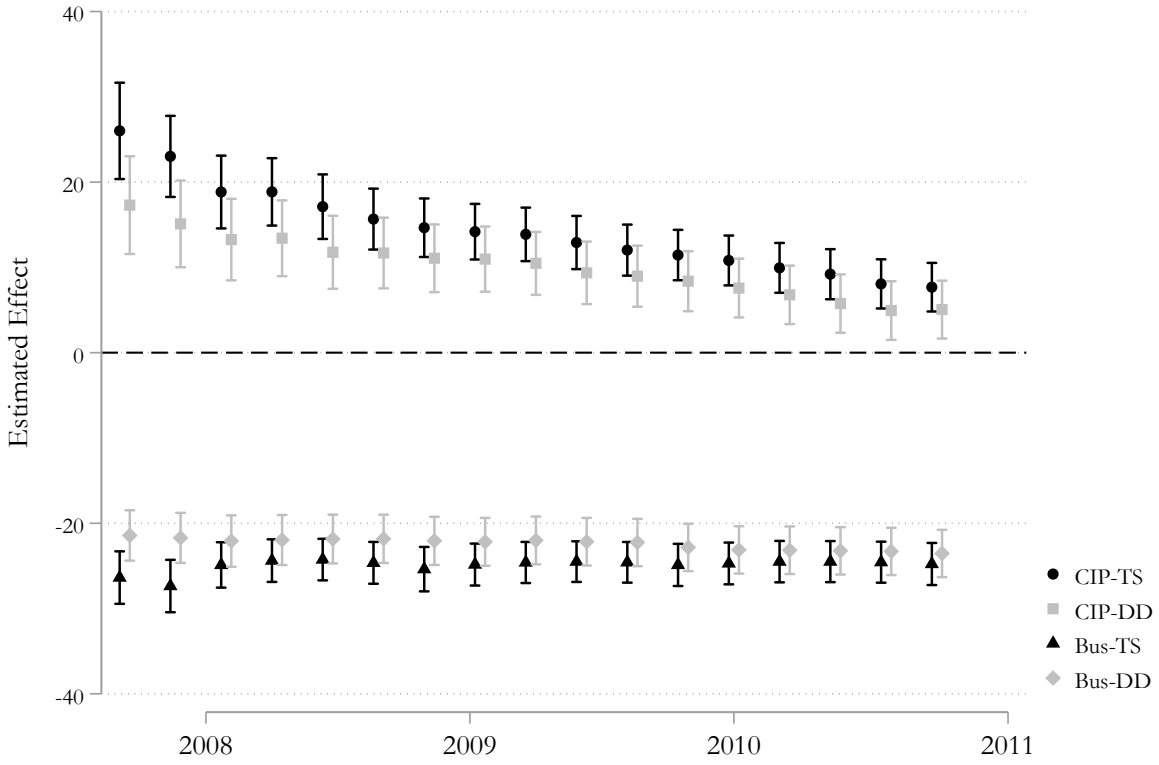
Figure 7: Crime Displacement Relative to the Extension of the Post-reform Period



Notes: Figure shows different estimates for the variation in total crime during the post-reform period, relative to the weekly average value in the transition period. 95 percent confidence intervals are plotted for each coefficient. The X-axis indicates the last week considered in the post-reform period. CIP represents the aggregate number of incidents in cash-intensive places which corresponds to incidents reported in local stores, supermarkets, gas stations and drugstores. Black coefficients are estimated using the interrupted time series design as indicated in the following equation: $crime_t = post_t + e_t$. The gray coefficients are estimated using difference-in-differences as indicated in the following equation: $crime_{it} = cash_i + post_t + cash \times post_{it} + e_{it}$. Coefficients are estimated from separate regressions for each location, type of regression, and number of weeks considered in the post-reform period. All regressions include month fixed effects and robust standard errors.

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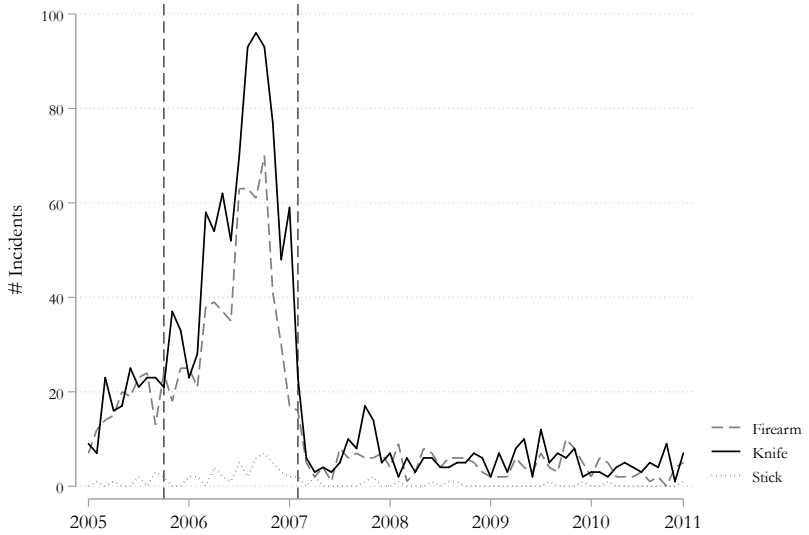
Figure 8: Monthly Evolution of Cash Robberies on Buses by Weapon Used



Notes: Lines connect the monthly evolution of cash-related robberies by weapon used. Vertical dashed lines show the beginning of the transition (October, 2005) and post-reform (February, 2007) periods.

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