Does Crime Influence The Payment Decisions Of Consumers?

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ABSTRACT

The impact of crime on economic activity has been widely studied. The economic analysis of crime on payment instrument, however, is still lacking. In this paper, we analyze the impact of crime on the use of cash and card payment with an original database of a representative sample of French consumers. We provide empirical evidence that violent and financial crimes have opposite effects on cash withdrawn and cash payment: On the one side, violent crime increases the amount of cash withdrawn and increases the probability of a cash payment. On the other side, financial crime decreases the amount of cash withdrawn and increases the probability of a credit or debit card payment. The probability of mugging is higher when withdrawing cash and automated teller machines (ATMs) deliver only notes. The increase in the amount of cash withdrawn comes from the reduction of the number of cash withdrawals together with the non-linearity of cash withdrawals at ATMs. The increase in the proportion of card owners when financial crime is high is a result of adverse selection: a financial fraudster is more aware of the insurance provided with payment cards, and therefore he places a greater value on having a payment card.

Keywords: Crime Economics; Payment Instrument; Card; Cash

INTRODUCTION

Since the founding paper analyzing crime as the result of rational calculation (Becker, 1968), the economic literature crime massively grew as attested by different surveys (Cameron, 1988, Becker, 1995, Eide et al, 2006, Benson and Zimmerman, 2010, Kshetri, 2010). The academic investigation on the impact of crime as an environmental factor on general economic activity is scant at best.[1] The impact of crime as an environmental factor in the choice of payment instrument, however, has not been studied to the best of our knowledge except from a theoretical standpoint (Bolt and Chakravorti, 2008). In Bolt and Chakravorti (2008), the probability of street mugging decreases the probability of using cash. Shy and Tarrka (2002), introduce a probability of fraud, but this ad hoc parameter is neither discussed, nor endogeneized. The probability of fraud allows for an equilibrium with all payment instruments represented, which is arguably more elegant. From an empirical standpoint, the impact of crime on the choice of payment instruments has been studied in Karoubi (2012) and Karoubi (2015). Karoubi (2012) studies the impact of crime on the preference for cash of merchants, and Karoubi (2015) focuses on the impact of crime on card acceptance. However, to the best of our knowledge there is no study that aims to shed light on the impact of crime on the use of payment instruments focusing on the perspective of the buyer. The present article is an attempt to fill the gap by exploiting an original database of a representative sample of consumers.

More precisely, we use a unique database of 1392 representative French consumers. The database comprises the declared preference for payment instruments and socio-cultural characteristics. We have merged department level crime indicators–a department is a geographical regional division similar to a county–with the individual dataset, according to the department of the consumer. The available crime indicators correspond to each crime defined in the French nomenclature of crime and offenses. The crime indicators control for both violent

[1] Even though asymmetric information problems are useful conceptual tools to analyze scams and frauds (moral hazard and adverse selection problems are relevant only in explicit contracts).

crimes (Clark and Davis, 2011) and financial crimes (Luiz, 2002) and are among the least correlated.

We give empirical evidence that the more violent crimes there are, the higher the amount withdrawn in cash, and the less the number of residents holding a card. Symmetrically, we find that the more financial frauds there are, the lower the amount withdrawn in cash, and the larger the number of residents holding a card. Our results confirm that crime is an environmental factor that directly influences the choice of payment instrument. By linking crime to payments, this paper provides insights shedding light on an original aspect of crime economics.

DATA

The main data set was collected from a field inquiry. The sample is representative of the French population in profession, income and geographical origin. We used the stratum method to build the sample (we divide the population in multiple homogeneous disjoint groups, and we select independent subsamples inside each group). Consumers describe their behavior and preferences toward payment instruments by answering a questionnaire submitted by phone. Consumers also detail their socio-cultural characteristics.

Table 1 provides the descriptive statistics for the main variables, which we discuss in the next section. Table 2 describes all the variables used in the econometric models. We extract all crime variables from the Etat 4001, a document published by the French Home Office (Ministère de l'Intérieur) counting all complaints in French police stations and gendarmeries for each department. Because we aim to provide evidence of an environmental effect, the relevant crime data are aggregate. The ideal level of aggregation would be zip code or commune, but unfortunately the number of crimes is not available at a smaller level than the department.

We append to the main dataset crime variables of 2005 (year of the individual variables) and crime variables of 2004. We have merged the databases according to the department of the individual (for instance, the crime variables of a consumer from Paris correspond to the department 75). We divide the two crime variables by the number of inhabitants in the department, obtained through the INSEE website, to neutralize the size effect (a department can be more populated than another).

We now describe the dependent variables retained to characterize the payment behavior of consumers (Table 1), and more specifically their relation to cash and card payments (Table 2).

Table 1. Descriptive Statistics

Variable	Min	Max	Std Dev	Mean	Median
ATM Amount	10	1200	98.51	86.06	60
Payment Card	0	1	0.39	0.81	1
ATM Per Capita	0.50	1.07	0.11	0.72	0.71
ATM Per Square Meter	1.62	2198.10	351.25	89.62	10.77
Payment Per Capita	8.31	25.12	3.09	12.45	12.22
Surcharge	0	1	0.47	0.33	0
Withdrawal Place	1	4	0.51	1.90	2
Income	1	8	2.15	3.54	3
Gender	0	1	0.50	0.43	0
Age	18	93	16.44	44.86	42
Married	0	1	0.49	0.62	1
Degree	1	7	1.89	3.83	3
No Cash Risk	0	1	0.48	0.65	1
Number of Purchases	0	40	6.23	11.98	11
Average Purchase Amount	0.64	471.60	26.49	29.79	24.38
Number of Banks	1	3	0.44	1.21	1
Number of Banking accounts	1	4	0.56	1.32	1
Account Checkout Frequency	1	5	1.12	2.86	3
Financial Frauds, 2004	0.30	12.49	1.80	5.25	4.90
Financial Frauds, 2005	0.34	12.01	1.69	5.0	4.57
Street Crime, 2004	1.49	55.88	11.70	30.86	31.41
Street Crime, 2005	1.44	56.58	11.29	29.17	29.70
Violent Theft, 2004	0.03	7.86	1.71	1.74	1.35
Violent Theft, 2005	0.04	7.86	1.77	1.80	1.27

Street Crime, 2005	Continuous variable. Count of complaints filed for Street Crimes in the department for a thousand inhabitants, year 2005. The department "Nord" has the lowest rate. The department "Bouches du Rhône" has the highest rate, followed by the department "Seine Saint Denis" and the department "De France" (the Paris department).
Violent Theft, 2004	Continuous variable. Number of complaints filed for Violent Theft in the department for a thousand inhabitants, year 2004. The department "Nord" has the lowest rate. The department "De France" (the Paris department) has the highest rate, followed by the department "Seine Saint Denis".
Violent Theft, 2005	Continuous variable. Number of complaint filed for Violent Theft in the department of the consumer for a thousand inhabitants, year 2005. The department "Nord" has the lowest rate. The department "Seine Saint Denis" has the highest rate, followed by the department "De France" (the Paris department).

Table 2. Description of the Variables Used in the Econometric Models

ATM Amount	**Continuous variable. Amount typically withdrawn at ATMs per week. 94.85% of weekly withdrawals are less than 200 euros.**
Payment Card	Binary variable. The variable is 1 if the consumer owns a payment card.
ATM Per Capita	Continuous variable. Number of ATMs per inhabitant in the department. 53.88% of the consumers live in a department with less than 0.71 ATM per capita.
ATM Per Square Meter	Continuous variable. Number of ATMs per square meter in the department.
Payment Per Capita	Continuous variable. Number of payment card accepting shops per inhabitant in the department
Surcharge	Binary variable. The variable is 1 if the bank charges cash withdrawals, else it is 0.
Withdrawal Place	Polytomic variable. The variable is 1 if the consumer withdraws the money mainly at the counter of the bank, 2 if he or she withdraws mainly at ATMs, 3 if another person mainly withdraws for the consumer, and 4 if the consumer never withdraws.
Gender	Binary variable. The variable is 1 if the consumer is woman, and is 0 if the consumer is a man.
Age	Continuous variable. Age of the consumer.
Married	Binary variable. The variable is 1 if the consumer is married, else it is 0.
Degree	Ordered polytomic variable. The variable has seven modalities, and a higher modality corresponds to a higher degree. Modalities range from "No Degree" to "Master's Degree and Higher".
Income	Ordered polytomic variable. The variable has eight modalities. A higher modality correspond to a higher income.
No Cash Risk	Binary variable. The variable is 1 if the consumer considers that holding notes and coins involves a significant risk. The first modality corresponds to a null perceived risk.
Number of Purchases	Continuous variable. Average number of purchases performed in a week.
Average Purchases Amount	Continuous variable. Average amount of purchases the performed in a week.
Number of Banks	Ordered polytomic variable. Number of banks holding accounts for the consumer. A little more than four consumers out of five have a single bank.
Number of Banking Accounts	Ordered polytomic variable. Number of accounts of the consumer. 72.54% of consumers have a single banking account.
Account Checkout Frequency	Ordered polytomic variable. The variable has five modalities, ranging from "every day" to "less than once a month". A little more than two thirds of the sample (67.10%) checks the account less than once every 15 days.
Financial Frauds, 2004	Continuous variable. Count of complaints filed for Financial Frauds in the department for a thousand inhabitants, year 2004. The department "Nord" has the lowest rate. The department "Ile de France" (Paris department) has the highest rate, followed by the department "Val de Marne", the department "Hauts-De-Seine" and the department "Seine Saint Denis" (the departments are all in the Paris region).
Financial Frauds, 2005	Continuous variable. Count of complaints filed for Financial Frauds in the department of the consumer for a thousand inhabitants, year 2005. The department "Ile de France" (Paris department) has the highest rate, followed by the department "Ille et Villaine", the department "Bouches du Rhône" and the department "Hauts-De-Seine".
Street Crime, 2004	Continuous variable. Count of complaints filed for Street Crimes in the department for a thousand inhabitants, year 2004. The department "Nord" has the lowest rate. The department "Bouches du Rhône" has the highest rate, followed by the department "Île de France" (the Paris department) and the department "Seine Saint Denis".
Street Crime, 2005	Continuous variable. Count of complaints filed for Street Crimes in the department for a thousand inhabitants, year 2005. The department "Nord" has the lowest rate. The department "Bouches du Rhône" has the highest rate, followed by the department "Seine Saint Denis" and the department "De France" (the Paris department).
Violent Theft, 2004	Continuous variable. Number of complaints filed for Violent Theft in the department for a thousand inhabitants, year 2004. The department "Nord" has the lowest rate. The department "De France" (the Paris department) has the highest rate, followed by the department "Seine Saint Denis".
Violent Theft, 2005	Continuous variable. Number of complaint filed for Violent Theft in the department of the consumer for a thousand inhabitants, year 2005. The department "Nord" has the lowest rate. The department "Seine Saint Denis" has the highest rate, followed by the department "De France" (the Paris department).

We aim to evaluate a modification on cash usage. We now discuss the choice of a dependent variable for our econometric model. Cash spent per a fixed time period appears to be the natural candidate. It is difficult, however, to build a representative sample that keeps track of cash spent with sufficient reliability, because the process would involve high cognitive costs or a significant organization. Therefore, we retained the best proxy easily available, the amount of cash withdrawn at an automated teller machine (ATM) per week. A consumer can withdraw cash at the counter of his or her bank but the amounts are negligible compared to the amount withdrawn at ATMs (the proportion is less than one in a hundred in our database).

In the sample, 21.54% of the consumers however (*i.e.,* 300 out of 1,392 individuals) do not withdraw cash. Therefore, an individual using an ATM may have systematic common characteristics explaining their withdrawal choice and biasing the results. We therefore estimated a Heckman selection model to correct for this potential selection bias. The selection equation explains the choice of using an ATM to withdraw money.

We also aim to evaluate a potential modification of card usage. The amount of card transactions performed in a fixed period is a natural candidate for our choice of dependent variable; it is not available however, and the evaluation of this amount by the consumer is not reliable. A dummy controlling for having a card is an interesting proxy. Most French cards allow both cash withdrawals and card payments. [2] Therefore, we decide to retain the dummy controlling for having a payment card as a dependent variable.

Independent Variables

We consider the same independent variables to model the weekly cash withdrawal, the usage of an ATM (for the selection equation) and the decision of having a payment card because it is plausible that the reasons for withdrawing more or less cash also affect the usage of ATM and influence the decision of having a payment card. We now turn to examining the variables.

We separate the variables into three disjoint sets: the variables related to the cost of cash withdrawals and to the cost of card payments, the consumer controls, and the variables controlling the relation of the customers to the banks. The first subset of variables is related to the cost of withdrawing cash and the cost of card payments. For instance, the variables identified in Baumol (1952), Tobin (1956), and Karoubi and Chenavaz (2015) have a crucial role in the decision to withdraw cash.

The first subset of variables are related to the cost of cash withdrawals and affect the decision of having a payment card because payment instruments are imperfect substitutes.

The ATM population density and the **ATM spatial density** impact the "shoe leather cost", that is, the hardness of moving to an ATM. Recall that the representative consumer of the inventory theoretic model of cash demand earns a fixed income during each period. The consumer faces a continuous need for cash holding to carry out transactions. A conclusion of the model is that the optimal number of cash withdrawals is proportional to the square root of the costs of cash withdrawals and the inverse of the interest rates.

The number of **payment points per capita** is the main control for the level of acceptance of payment cards by merchants.

The **withdrawal place** controls for the usual hardness of cash withdrawals. A higher value corresponds to a lower average effort for cash withdrawing. Indeed, the first modality corresponds to a withdrawal at the bank counter, the second to a withdrawal at an ATM, the third to a withdrawal by a third person, and the fourth to a consumer who does not withdraw cash. [3]

The second subset of variables refers to the characteristics of the consumer.

[2] Some cards exclusively allow cash withdrawals though (111 consumers own a withdrawal only card, out of 1,131 card owners).
[3] We estimate regressions in which we introduce dummies for each of the four modalities of this variable and the results that concern crime proxies (sign and significance of the associated coefficients) were stable.

Gender significantly affects payment patterns; Burg and Toussaint (2011) find that women use checks more often, because they can put their checkbook in their purse.

Age impacts the psychological relation to money, and therefore payment patterns. For instance, older people tend to distrust electronic payment instruments; children and teenagers usually receive and spend their pocket money in cash.

We introduce a binary variable that controls for whether the consumer is **married**, because husband and wife may have a specific pattern of use for a bank-related payment instrument (they may debit a join bank account by using a specific card).

Educated people tend to be more willing to use credit card payments, and a higher **degree** is associated with a more intellectual job. The profile of consumption and therefore the payments instruments used are different.

A low-**income** individual chooses a payment instrument at least partly for the management of cash flow (he or she is more likely to use card or other payment instruments with deferred debit like check) whereas high-income individual buys higher-priced goods, and is less likely to use cash.

The perceived **subjective risk** of cash payments implies more reluctance to carry and use cash. Therefore, we introduce a categorical variable to control for the risk that a consumer associates with cash.

Some cognitive costs (e.g., the calculation of the total payment value or division of the total price in coins and notes) increase with the **number of purchases**, and the costs are particularly significant when the consumer pays cash. Prices are usually set immediately lower than a psychological barrier (e. g. 10, 100, 1,000 and so on currency units).

The transaction size plays an important role in the choice of the payment instrument (see, for instance, Gerdes and Walton, 2005). Therefore the **average value of total purchases** is relevant to the decision to use cash.

The **type of profession** controls for the work status of the consumer, which affects the consumption profile because it is a proxy of the socio-cultural environment and of the lifestyle.

The last set of variables control for the relationships of the consumers to the banks.

We introduced a binary variable controlling for the **number of bank accounts** that the consumer owns. Indeed, an individual with multiple bank accounts may find it more convenient to pay by card because of the possibility of switching between bank fees associated with each account or because multiple accounts make it easier to manage different types of expenses.

We also introduced a dummy variable indicating whether the bank of the consumer charge withdrawals at ATMs outside the network, denoted a **surcharge**. The inquiry was carried out before this practice became generalized in July 2002 and roughly one consumer out of three is subject to surcharges in the sample.[4]

An individual with multiple accounts held by different banks has an additional degree of freedom relative to the situation in which he or she is affiliated with a single bank (even if the latter holds multiple accounts). For instance, it is impossible for a bank to block an account as a result of a deficit of another account or to transfer the surplus of one banking account to cover the deficit of another one. Therefore, we introduced a dummy for the number of **account-holding banks**.

[4] In July 2002, euro regulation was implemented, and banks had to unify the pricing across Europe. Most French banks reacted by implementing surcharges. Usually, the three or four first withdrawals at an ATM that does not belong to the network of the bank are free, and the following are priced at 1 euro each.

The perceived cost of using the payment card may vary with the **account checkout frequency**. Moreover, an individual checking his account is often more cautious in spending money. She is likely to be more aware of bankcard fees, and is thus more able to make an informed decision about the ownership of a payment card.

RESULTS

It seems reasonable to assume that all missing regressors are normally and identically distributed (NID) in a regression explaining the decision of having a card, so that the central limit theorem applies, and that the residual is approximately Gaussian. Therefore, we estimate a classic probit.

We estimate a Heckman selection model to explain the amount of cash withdrawn. Indeed, consumers that withdraws cash at ATMs may have systematic common characteristics which could influence the amount withdrawn. Table 3 presents the results.

Table 3. Estimation Results

	(1)	(2)	(3)	(4)
ATM Population Density	-25.1	-52.7	1.25[d]	1.00
	(51.1)	(49)	(0.74)	(0.75)
Density of Payment Card Points	2.96[d]	2.48	-3.96e-03	-8.62e-05
	(1.74)	(1.72)	(2.57e-02)	(2.57e-02)
Surcharge	6.99	6.28	0.57[a]	0.58e[a]
	(6.22)	(6.26)	(0.1)	(0.1)
Withdrawal place	13.4	13.3	0.44[a]	0.45[a]
	(14.5)	(14.5)	(0.08)	(0.08)
Gender	9.87	9.40	0. 16[d]	0. 16[d]
	(6.13)	(6.13)	(0.09	(0.09)
Age	0.63[b]	0.58[b]	-5.47e-04	-5.97e-04
	(0.22)	(0.22)	(2.74e-03)	(2.74e-03)
Married	-0.02	0.46	0.19[c]	0.19[c]
	(6.51)	(6.52)	(0.09)	(0.09)
Degree	-6.67[a]	-6.64[a]	0.12[a]	0.12[a]
	(1.69)	(1.69)	(0.02)	(0.02)
Subjective risk	11.6[d]	10.3	-0.41[a]	-0.41[a]
	(6.32)	(6.29)	(0.10)	(0.10)
Number of purchases	1.50[b]	1.51[b]	2.83e-03	3.31e-03
	(0.51)	(0.51)	(0.01)	(0.01)
Average purchase Amount	0.09	0.10	4.14e-03[c]	4.38e-03[c]
	(0.14)			
Account checkout Frequency	-4.89[d]	-4.83[d]	-0.05	-0.06
	(2.74)	(2.74)	(0.04)	(0.04)
Street crime, 2004		1.03[c]		
		(0.47)		
Violent theft, 2004	9.57[c]		-0.1[d]	
	(3.73)		(0.05)	
Financial frauds, 2004	-5.03[d]	-6.96[d]	0.10[c]	
	(3.04)	(3.82)	(0.04)	
Violent theft, 2005				-0.11[c]
				(0.05)
Financial and economic frauds, 2005				0.11[c]
				(0.05)
N	1383	1383	1383	1383

Notes: [a] p<0.001, [b] p<0.01, [c] p<0.05, [d] p<0.1. Standard errors are in parentheses. Column (1) and (2) present the estimation of the main equation of the Heckman selection model with different crime indicators. The dependent variable is the weekly amount withdrawn at ATMs. The selection equation is not reported here for the sake of conciseness. Column (3) and (4) present the estimation of the probit model with different crime indicators. The dependent variable is a binary variable equaling 1 if the consumer owns a payment card. The constant is not reported for all models presented.

We first discuss the regression explaining the amount of cash withdrawn in a week. Current year (*i.e.,* 2005) crime indicators are not significant, as opposed to previous year crime indicators (*i.e.,* 2004). Consumers observe the level of crime before reacting.

Both our indicators of violent crime (violent theft and street crime) have a positive impact on the amount withdrawn at ATMs in a week. The result is counterintuitive because we would expect a consumer to reduce the sum she carries to reduce his or her liability to violent theft. We can however explain this result by considering that the real danger is withdrawing cash. Indeed, a withdrawal is visible and it is performed at ATMs, that is, at a specific place known by a potential attacker. A rational consumer would increase the average sum withdrawn to reduce the number of withdrawals. Because most ATMs deliver exclusively notes of 10 or 20 euros, fine-tuning the sum withdrawn is impossible, and therefore an increase in the average sum withdrawn may imply a higher amount withdrawn. It is unfortunately impossible to perform a reliable test that proves the number of withdrawals decreases when violent crime increases, because we do not observe the number of withdrawals in a fixed period of time.

Our indicator of financial frauds has a negative impact on the weekly amount of cash withdrawn. In a department where financial frauds are common, cash is less frequent. Financial frauds typically concern high amounts, and often involve accounting manipulations. Cash payments are less common when prices are high (Whitesell, 1989), and cash withdrawals at an ATM are obviously out of the question for a firm planning to perform accounting manipulations.

In the regression with the dummy controlling for having a card as a dependent variable, both current year and previous year crime indicators are significant. Consumers react to previously observed and to current crime. The indicator of violent crime (violent theft) has a negative impact on the decision of having a payment card. In other words, the more violent the crimes in the department, the fewer consumers have cards. This result is consistent with our conclusions on the amount of cash withdrawn. If a consumer withdraws higher amounts, she has less incentive to have a payment card, because cash is easier to use. The indicator of financial frauds has a positive impact on the probability of having a payment card. The more financial frauds there are in the department, the more consumers having a payment card. This result is consistent with our conclusions regarding the weekly amount of cash withdrawn. Indeed, a fraudster is typically an expert on financial questions and is aware of the risks associated with cash payments, as well as the insurance provided with card payments. The consumer is more prone to ensure his or her legitimate payments by using payment cards.

For both regressions, the inclusion of department level dummies is not possible. Indeed, for the regression with the weekly amount of cash withdrawn as dependent variable, the likelihood is not concave, and the Limited Information Maximum Likelihood (LIML) estimator obtained by performing a two-step estimation *à la* Heckman is not reliable; various variables are dropped because of multicollinearity and because some observations are determined to be linear combination of the independent variables. The estimated standard errors are therefore questionable. The estimation of the probit with the dummy controlling for having a payment card as a dependent variable suffers the same problems. The database, although containing a sizable number of observations (1407 consumers) is not big enough to fit satisfingly a model with more than 120 variables.

We estimate the regressions using a cluster robust estimation (each department is considered to be a cluster) to ensure that we captured a crime-related effect and not merely a department-fixed effect. The results are qualitatively the same, though the significance of crime variables is slightly degraded.

CONCLUSION

This article focuses on the impact of crime on the use of payment instruments. We use a unique database of a representative sample of consumers. We enrich the database with department-level crime indicators that we extracted from the Etat 4001, a document published by the French Home Office (Ministère de l'Intérieur) that gives the count of all complaints filed in French gendarmeries and police stations. We retain two indicators of violent crime (street crime and violent theft) and one indicator of financial frauds.

We show that the more violent crime in a department, the higher the weekly amount withdrawn in cash, and the fewer consumers having a payment card. This is a consequence of a reduction of the number of withdrawals while maintaining total amount withdrawn because ATMs typically deliver only notes. We also show that the more financial fraud in a department, the lower the amount of weekly cash withdrawals and the more consumers having a payment card. Indeed, the average financial fraudster is an expert: he or she is more aware of the risks associated with cash payments, and he or she places greater value on the insurance that goes with card payments. The present paper concludes that the impact of financial crimes on the use of card is also twofold: violent crime increases the acceptance of payment card, and financial fraud decreases the likelihood of card acceptance, while increasing the likelihood of having a card.

AUTHORS

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