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Does crime influence the merchants' preference for cash? Evidence from France.

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Abstract

This paper is an attempt to determine whether crime as an environmental factor has a significant impact on merchant preference for cash. I exploit a unique database from a representative sample of merchants and show that crime has a twofold impact on the merchant subjective preference for cash. I build an indicator composed of theft variables concerning primarily both consumers and merchants. I find that a merchant whose store is located in a department in which my indicator is high has Ceteris Paribus a lower than average preference for cash. I also find that a higher level of financial fraud increases it. The first effect is interpreted to be the result of a precaution motive (cash payment and storage involve risk of loss and theft), while the second results from adverse selection (cash payments make tax evasion easier).

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1 Introduction

Electronic payment instruments are cheaper to produce, easier to stock, and less liable to fraud than cash. To give an order of magnitude, Humphrey *et al* (2003) estimates that "an electronic payment costs one third to one half that of a paper based instrument", so that "a country may save 1% of its gross domestic product annually as it shifts from a fully paper-based to a fully electronic based payment system".

Therefore, understanding the determinants of the payment instrument choice is a high stake challenge for the social planner.

However, the impact of crime *as an environmental factor* on payment instrument has not been investigated so far to the best of my knowledge, except from a theoretical standpoint in a paper by Chakravorti and Bolt (2009). In their model, the probability of street mugging decreases the probability of using cash.

Note that the payment instrument choice involves two asymmetric sides: the merchant side decides whether she accepts alternative payment instruments;[1] the consumer side decides which payment instrument she holds and which will effect the transaction conditional on merchant acceptance. Therefore, the bank payment card market is analyzed as two-sided, because the network's profit depends not only on the raw number of users, but also on the proportion of merchants and of card bearers (Tirole, 2003, gives a theoretical analysis of the impact of those cross side network externalities).

Both sides have a decisive impact on the payment instrument effecting the transaction. However, the merchant side is almost systematically neglected by empirical academic research. To the best of my knowledge, there are extremely few empirical studies investigating the question of crime impact on merchant payment behavior in general.

This paper is an attempt to fill this gap. I study the impact of crime on merchant preference for cash payments. Since merchants can not turn down cash, their declared appreciation for this payment instrument appears to be the natural candidate for studying the impact of crime on their relation to cash.

I find that the level of theft in the department decreases merchants' preference ratings for cash while a high level of financial fraud increases it.

The remainder of this paper is organised as follows. In section 2, I describe the dataset and discuss the econometric models. In section 3, I present and discuss the results. A conclusion is given in section 4.

2 The Data and Econometric Strategy

2.1 The Data

The data was collected from a field inquiry conducted from March to May 2008. The sample is designed to be representative of the French population of merchants in size, sector and location.

Merchants answered questions by phone regarding their behavior and preferences towards payment instruments. They also provided controls for their position in the business, and for their customer's relevant socio-demographic characteristics. The dataset comprises

[1] Merchants can not turn down cash because it has legal tender in most countries.

variables related to payment patterns and individual characteristics. 4601 merchants were surveyed, of which 3983 answered all the questions coded into variables used in the econometric models.[2]

Table 1 provides descriptive statistics for the main variables, discussed in the next section. Table 2 describes all the variables used in the econometric models. Mean and standard errors of polytomous variables are provided. For ordered binary variables, the mean and the standard error of the corresponding ordered polytomous variable[3] are briefly discussed. Short comments about the proportion of merchants represented by grouping of modalities, or grouping of ordered binary variables are also presented.[4]

All crime variables were extracted from a document coming from the French "Ministère de l'Intérieur", the "État 4001" for the year 2008. This document provides the number of complaints filed in Police Stations and Gendarmeries for all French departments and for all charges defined by the French nomenclature of crime and offenses. I divided this raw count by the departmental population[5] in order to neutralize the size effect, as the number of inhabitants can vary greatly between departments. Note that a department is a geographical division like a state or prefecture, intermediate in size between a town and a region.

Table 1: Descriptive Statistics

	Mean	Standard error	Definition
Pref. rating for cash	3.55	1.67	Merchants' preference ratings for cash on a Likert scale, graduated from 1 to 5.
Fraud and breach of trust	4393.30	4742.30	Number of "Swindling and breach of trust", as defined by the French nomenclature of crime and offenses, declared to French Police stations ans Gendarmeries for each department for the year 2008.
Overall Theft	7755.37	6678.92	Sum of the number of complaints filed for "Theft committed in a vehicle" , "Theft against individuals" , "Armed robbery" as defined by the French nomenclature of crime and offenses, declared to French Police stations and Gendarmeries, for each department for the year 2008.
Fraud and breach of trust (for 1000 inhabitants)	4.01	2.52	Same as Fraud and breach of trust, but for 1000 inhabitants.
Overall Theft (for 1000 inhabitants)	7.21	3.58	Same as Overall theft, but for 1000 inhabitants.

2.2 The Econometric Model

As discussed earlier, there is an important asymmetry between merchant and consumers: the consumer decides which payment instrument she holds *as well as* the one effecting the

[2]Missing answers are randomly distributed, and therefore the estimation sample does not suffer from selection bias. Indeed, I performed a Kendall's tau test of independence between the participation and preference ratings, since the former variable is binary and the latter is ordered. The null of independence clearly can not be rejected, for Kendall's score is 17342, with a continuity corrected standard error of 31702 and a P-value of 0.5844.

[3]The i^{th} modality of this variable equals 1 when the i^{th} binary variable equals 1.

[4]Note that modalities are not mutually exclusive. For instance, a merchant can declare having many customers in their twenties and many customers in their fifties; in that case, both relevant binary variables equal 1. The second and fifth modality of the corresponding ordered polytomous variable also equal 1.

[5]The departmental population was extracted from the INSEE website.

Table 2: Description of the variables

Variable	Definition	Observations
Average Customer Wealth	Merchant estimation of their customer's average wealth. 5 classes are proposed, each class is included as a dummy variable, equaling 1 if the customers belongs to the relevant wealth class, and 0 otherwise.	3 merchants out of 4 (*i.e.* 74.38% of the sample) declare they have middle class customers. The weighted average is 3.03 - modality 3 is middle class- and representative enough of the whole distribution since the corresponding polytomous ordered variable's standard error is 0.68.
Average customer age	Merchant estimation of their customer's average age; 7 classes are proposed, each class is included as a dummy.	The average customer is on his late thirties and is representative enough (the weighted average is 3.82 - modality 3 is "a significant part of my customers are on their thirties" and modality 4 is "a significant part of my customers are on their forties" - and the corresponding polytomous ordered variable's standard error is 1.01) . A little less than two thirds of the merchants in the sample- 62.33% - declare that a significant part of their customers are on their thirties.
Distance to the customer's living place	Distance from the store to the customer's living place; 5 classes are proposed, each class is included as a dummy.	The average consumer comes from the same town as the store but not from the immediate vicinity (the weighted average is 2.06 -modality 2 is "town"- and representative enough of the whole sample since the standard error of the corresponding polytomous ordered variable is 0.64. A big half of merchants in the sample declare having customers from the vicinity, and more than 4 out of 5 declare having customers from the same town (respectively 53.44% and 83.54%.).
Distance to the closest ATM	Distance from the store to the closest ATM; This variable has 5 modalities, sorted from nearest to farthest.	The average distance from the store to the closest ATM ranges between 50 and 100 meters (this variable has a mean of 2.4 and a standard error of 1.44). This distance is less than 500 meters for roughly 3 merchants out of 4 (74.28%), and is more than 1 kilometer for 1.3% of merchants in the sample.
Frequency of cash refusal	Merchant estimation of cash refusal frequency; This variable has 5 modalities, sorted form less frequent to more frequent, in increasing order.	The average merchant refuses cash infrequently, which is expected since cash has legal tender in France (this variable has a mean of 4.3 - modality 4 is "I refuse cash infrequently" - and a standard error of 1.48). A little less than 4 merchants out 5 of never refuse cash (78.75%).
Frequency of check refusal	Merchant estimation of check refusal frequency. This variable has 5 modalities, sorted from more to less frequent.	The average merchant refuses check rarely, which is expected since checks are often used in France (this variable has a mean of 4.2 - modality 4 is "I refuse check payments infrequently" and a standard error of 1.41). A little less than 2 merchants out of 3 never refuse check (65.77%).
Frequency of bank cards refusal	Merchant estimation of bank cards refusal frequency. This variable has 5 modalities, sorted form more to less frequent.	Merchant accepting bank cards almost never refuse bank cards payments, which is expected since merchants are theoretically forced to accept a bank card if they display the relevant logo (this variable has a mean of 4.7- modality 5 is "I never refuse bank cards"- and a standard error of 0.6 for card accepting merchants). A little less than 4 out of 5 card accepting merchants never refuse bank card.
Cash transport frequency	Merchant estimation of cash transportation to the bank; This variable has 7 modalities, ranging from more to less frequent.	The average merchant moves cash to the bank from times to times to often. This variable has a mean of 2.59 - modality 2 is "I move cash to the bank once a week", and modality 3 is "I move cash to the bank several times a week"- and a standard error of 1.42. A little third of the sample moves cash to the bank once a week or more (32.62%.).
Fake Note detector	Dummy variable, equals 1 if the merchant owns a fake note detecting device, 0 otherwise.	Roughly one merchant out of five owns a fake note detector (this binary variable has a mean of 0.21).
Business creation	Dummy variable, equals 1 if the present owner created the firm, 0 if ownership results from a takeover.	A small half of merchants in the sample created their firm (this binary variable has a mean of 0.48 and a standard error of 0.51) .
Cash fraud frequency	Merchant estimation of the frequency of payments with fake notes and coins; This variable has five modalities, from more to less frequent.	The average merchant is presented with cash fraud very infrequently (this variable has a mean of 4.3 - modality 4 is "I am presented with fraud infrequently" and modality 5 is "I am never presented with fraud"- and a standard error of 1.48). A little more than 1 merchant out of 5 is presented with cash fraud infrequently, and a little more than 3 out of 5 is never presented with cash fraud (respectively 22.69% and 61.88%).
Store area	Store area, in square meters.	This variable is very dispersed (its standard error of this variable is 566.65, more than twice its mean, 185.8). However, note that a little more than three merchants out of 5 - 61% to be precise- have a store area ranging from 20 to 100 square meters.

transaction, while merchant decides which alternative payment instrument she accepts once and for all. This decision is sunk when an individual transaction occurs. Thus, an objective measure of merchant preference for cash is uneasy to collect.

Therefore, the independent variable I chose is a proxy for the merchants declared "cash appreciation". More precisely, I use the merchant rating of cash on a Likert scale (1 is the worst rating, 5 is the best).

I expect the merchant preference for cash (denoted Y) to vary according to the store

type and equipment, once controlled for the consumer characteristics. I also intend to check whether crime variables impact this preference.

The independent variables used in the econometric models can be grouped in three disjoints subsets: the consumer controls, those on the store type and equipment, eventually the environmental crime variables, which are department level.
In other words, we have:

$Y = f$(Crime variables, Store type, Consumer Controls)

I now briefly present the retained variables in each of the just cited subsets, starting with the crime indicators.

Crime Variables

First, note that bank card payments are very secure, compared to cash, the most used payment instrument for small value purchases (see for instance Federal Reserve Bulletin, 2005). There are many insurance policies against fraud, depending on particular cards and issuing banks. Moreover, a cash desk can be considered more provocative of theft, whether committed by employees or by shopbreakers, than a card terminal. Note that, due to the two sided structure of bank card markets, a partial internalization of the risk run by consumers is logical.

Therefore, I expect a variable representative of the overall level of theft (denoted T) both consumer and merchant side to impact negatively the preference rating for cash, i.e. **f'(T)**< 0 **(assumption (i))**.

Second, note that cash payment are anonymous and immediate, and maintaining a high stock of cash makes off the books payments, and therefore off the books hiring easier. I expect a variable controlling for the "propensity to financial fraud", denoted S, to impact positively the preference ratings for cash, i.e **f'(S)**> 0 **(assumption (ii))**.

I expect an effect of crime as an *environmental* factor. Therefore, the relevant data is aggregate. While the ideal level of aggregation would probably be zip code, or commune, the count of filed complaints at this scale is not available. I chose department level crime indicators as I considered them second best. I merged those crime indicators with individual level variables according to the store department.

I built an indicator of "Overall theft" (referred to as such in the remainder of this paper) as equal to the sum of three crime variables: "Theft committed in a vehicle", "Theft against public or private establishments" and "Armed robbery". The first is a form of theft which only concerns consumers, while the second and third respectively represent nonviolent and violent theft directed against merchants.

This indicator controls both for the direct risk run by merchants and for their partial internalization of the consumers equivalent. Note that the direct risk includes both the potential damage to the physical integrity and the potential financial loss in the event of a theft.

I also retained an indicator of financial fraud (Fraud and breach of trust).

Note that the retained crime variables were as little redundant and correlated as possible. Indeed, crime is self-breeding, creating a more friendly environment, and macroe-

conomic conditions can provoke the combined appearance of various crime forms[6] so that most crime variables give, in a sense, the same information.

Other Relevant Variables

First, the consumer controls are essential, as the final decision of the payment instrument effecting the transaction rests exclusively with the consumer, given the merchant acceptance decision. Therefore, the following variables may impact merchants' appreciation for cash.

The **distance to the customer's living place** may impact the payment instrument choice. For instance, a tourist living in a different currency zone has to consider additional criteria to choose between payment instruments. Thus, comparisons of the exchange rate charged when performing a card payment to the one charged by the change desk becomes relevant. Moreover, a customer living very close to the store is more likely to perform daily shopping, and transaction size is more likely to be limited; a customer from another region is more likely to be in holidays, which can obviously impact the consumption profile.

Payment instrument choice is closely correlated to **the average customer wealth**, because the latter obviously impacts the average transaction size (cash holdings are directly proportional to income flow in Baumol-Tobin's inventory theoretic model of money demand; See For instance Federal Reserve Bulletin, 2005, for empirical evidence). Therefore, merchants were asked to rate the level of income of their customer on a six-point scale (denoted customer wealth on the regressions).

the **average customer age** may affect payment behavior: for instance teenagers receive more often their pocket money in cash, and aged persons often distrust card payments.

Second, the store characteristics, its equipment and payment policy impact the convenience of paying by cash relative to other means of payment.

Possession of a fake notes detector may be correlated with the merchant's wariness of cash payments, or level of protection against fraud. In the same line of thought, a higher **cash fraud frequency** could be associated with a more negative opinion of cash.

When the ownership results from a takeover and not from a business **creation**, the capital bought by the previous owners is often kept, and banking contracts are not always renegotiated. Therefore, the cost of accepting cards is lower if payment terminals were bought previously, and in the same line of thought cash storage is less risky if cash handling and storage equipment are at disposal.

Obviously, a negative opinion of cash payments can explain a high **cash refusal frequency** - even though refusing cash is illegal in France; merchants disliking check or credit cards may appreciate anonymity, or independence from banking accounts of cash payments, characteristics opposite from those of the main alternatives.

A merchant confronted to a high **cash fraud frequency**, is more aware of the dangers associated with cash payments, and may therefore dislike them more in average.

The **distance to the closest ATM** is closely related to the "shoe leather cost" - i.e. the cost of moving to the ATM - in the aforementioned inventory theoretic demand for

[6]For instance, it is clear that poverty ridden areas are more exposed to all types of crime.

money.

The **store area** impacts the payment instrument policy. Indeed, a big shopping area implies a minimum level of sales. Therefore, such a store is more likely to host an important frequency of transactions; fastness of payment becomes more important. Moreover, large area stores often belong to a chain. Their payment instruments policy is generally decided at a central level.

The Econometric Strategy

It seems very plausible that potential missing regressors are independent and identically distributed, so that the Central Limit Theorem applies. Therefore, I estimate an ordered probit. [7]

Intra-departmental heterogeneity in crime indicators could bias the results. In order to address this question, I estimated all regressions on a sample of merchants located outside the Paris region, which is the most heterogeneous in France, as well as on the whole sample.

Eventually, it could be feared that the level discrepancy between aggregate crime variables and the remainder of the dataset, which is individual, would entail the capture of a department fixed effect rather than a crime-related effect. To deal with this problem, I included dummies for all departments except one. Moreover, because crime variables are at a higher level of aggregation, standard errors might be inaccurate because of intradepartmental correlations between residuals. Huber-White Sandwich estimator provides accurate variance since I have 90 clusters of balanced size (according to Kezdi (2004), 50 such clusters is close enough to infinity for accurate inference).

Testing assumption (i) and assumption (ii) is equivalent to testing the sign and significance of the crime variables.

3 The Results

Table 3 provides global adjustment statistics in order to compare the fit of econometric models and table 4 sums up the results of ordered probit estimations. For the sake of conciseness, only significant variables, at least for one of the two estimations, are shown.

[7] The probit model assumes that the residual follows a Gaussian distribution. By application of the Central Limit Theorem, an averaged sum of i. i. d. random variables follows asymptotically the very same distribution.

Table 3: Model fit comparisons: R^2, Chi-2 and Likelihood ratio tests.

		Standard variance estimation	Robust variance estimation
Model with dummies	LR test statistic, 116 degrees of freedom	426.03	Irrelevant
	Chi2 statistic, 22 degrees of freedom	292.85	320.63
	R^2=0.0327		
Model without dummies	LR test, 24 degrees of freedom	309.67	Irrelevant
	Chi2 statistic, 22 degrees of freedom	305.13	370.04
	R^2=0.0237		
P-Value are in parenthesis All chi-2 and LR tests reject the null with P-Values inferior to 0.0001			

Table 4: Merchant preference for cash

	Merchant preference for cash	
	All regions	Outside Paris
Overall Theft	-0.41 *** (-19.87)	-0.58 *** (-19.96)
Fraud and Breach of trust	1.17 *** (19.38)	1.95*** (20.23)
Customer Wealth: Wealthy	-0.07 ** (-1.82)	-0.09 ** (-2.02)
Customer Age: Twenties	0.04 ** (2.42)	0.08 * (1.64)
Cash fraud frequency	-0.15*** (-4.37)	-0. 14*** (-3.80)
Store Area	-1.04e−4 *** (-3.55)	-9.71e−5 *** (-2.94)
Distance ATM	-0. 02 (-1. 19)	-0. 02 *(-1. 67)
Cash refusal frequency	0.32 *** (9.12)	0.29 *** (8.05)
Check refusal frequency	-0.06 *** (-5.83)	-0.05 *** (-4.72)
Transportation frequency	-0.07 *** (-4.25)	-0.07 *** (-3.49)
Creation	-0.21 *** (-6.37)	-0.21 *** (-5.21)
Pseudo R	0.03	0.03
Chi-2 (P-Value)[8]	9827.75 (≤0.0001)	57630.52 (≤0.0001)
N	3983	3249

t statistics in parentheses
* (p¡0. 05) , ** (p¡0. 01) , *** (p¡0. 001)

Comparisons of Model Fit

There are 891 merchants in the Paris region, which amounts to 19.37% of the sample. On the one hand, eliminating them might not preserve the sample representativeness; On the other hand, heterogeneity in crime indicators might be excessive for the Paris region. Estimations on the whole sample and on the merchants located outside the Paris region yield essentially the same results. The significance and sign of variables are the same, and in particular for crime indicators (cf. table 4. Note that the "distance to the closest ATM" is significant at the 10% level in the restricted sample, but not significant on the whole sample. This is a threshold effect, since the difference between t statistics is small; moreover, it is the only such discrepancy). This tends to show that heterogeneity in crime indicators is not excessive, even if representativeness is preserved in the restricted sample. Therefore, sacrificing the information given by merchants from the Paris region appears unnecessary. I now turn to commenting the fit of the econometric models estimated on the whole sample based on table 3.

Note that model fit, evaluated by the size of the chi-squared statistic, is always better when intradepartmental correlation is taken into account by performing Huber-White sandwich estimations of standard errors. The chi squared testing the simultaneous nullity of all coefficients relative to micro level and crime variables[9] increases notably when department fixed effects are taken into account by the inclusion of departmental dummies (the number of degrees of freedom is 22 for both statistics, corresponding to the number of variables tested). Moreover, the crime indicators become highly significant as we will see below, instead of the opposite, though the direction of their impact remain constant

[8]Both Chi-2 provided have 24 degrees of freedom, corresponding to the number of micro level and

(maximum likelihood estimations of Overall theft's and Fraud and breach of trust's coefficients are respectively -0.78 and 0.3 with respectively a 44.5% and a 76% chance to be zero).[10]

All things considered, the most reliable model involves both department dummies in order to control for fixed effects, and robust variance estimation to take into account the potential intradepartmental correlation of cash preference ratings.

I now turn to discussing micro level variables and crime indicators.

Micro-Level Variables

The distance to the closest ATM is significant in the restricted sample, and has a negative impact on merchants preference for cash. This could be accounted for by merchants internalization of the consumers disutility associated with their "shoe leather cost".

Merchants refusing cash, those accepting check payments, those who do not frequently move their cash to the bank appreciate it less than average.[11] The first result is straightforward. Merchants who wish to limit the share of cash effected transactions have incentives to accept alternative payment instruments, which explains the second result. Merchant who consider that storing large sum in cash is dangerous tend to move their cash to the bank often, and also to dislike this payment instrument, which explains the third point.

A more counter-intuitive result is that the more merchant think frauds are frequent, the more they appreciate cash. This can be explained by a selection effect: merchants having a positive opinion on cash effect more transactions with this payment instrument- which can be achieved by refusing alternative payment instrument for instance- and are therefore more frequently confronted by fraud.

Card refusal frequency has no impact on the merchant preference for cash.[12] This result can also be explained by a selection effect. Indeed, a merchant who prefers bank card over cash will probably effect more transaction with the former payment instrument (the inconvenience associated with paying with many coins and notes is relevant for the merchant as well as for the consumer most of the times). Therefore, merchants will automatically refuse card payment more often.

Crime indicators

Crime indicators retained are all significant at the 1 % threshold.

First, note that Overall theft has a negative impact on merchant preference, which tends to show that a high level of theft risk triggers the desire to be paid with a more secure payment instrument so as to be protected against the risks of theft and loss and in order to keep track of transactions.

[10]Since the model without departmental dummies is arguably less reliable, detailed results are not shown here.

[11]Remember that frequency variables are coded so that lower values correspond to high frequencies.

[12]This doesn't imply that merchants refusing cards do not prefer to be paid in cash *for particular transactions*. Indeed, they can still consider such substitution is the best available option.

Second, the level of Fraud and breach of trust has a significant and positive coefficient. I interpret this as an adverse selection effect. Indeed, the more "average propensity to financial fraud" in the department, the more likely it is that businesses' employer (not necessarily merchants) will hire off the books workers - obviously paid in cash - both because these jobs are an important dimension of tax evasion, and because the pool of potential black market workers increases, making it automatically easier to fill such positions. Therefore, cash payments will be more frequent and merchants will be more experienced and equipped for handling cash in average. They will like it more.

Another line explanation for the latter effect, though less environmental, is that merchants themselves hire off the books workers, and therefore need cash to pay them.

4 Conclusion

In this paper, I exploit a unique database, coming from a representative sample of merchants, in order to determine whether crime as an environmental factor impacts merchants' preference for cash.

My indicator of Overall theft, concerning both merchants and consumers, has a negative impact on cash preference, out of a precaution motive: merchants prefer to be paid in a more secure payment instrument lest they be burglared, or in order to be preserved from the risk of theft or loss. [13]

I also find that a high level of Fraud and breach of trust, as an indicator of the "average propensity to financial fraud", is associated with a better opinion of cash. This is because of the anonymity and difficult tracking of cash payments: tax evasion or off the books job hiring are of course easier to perform when payments are effected in cash (this confirms Ricciarelli, 2007, on the use of cash for illegal behavior) .

[13]Even though insurance may guarantee reimbursement of stolen cash for merchants, such guarantee is costly, and theft by employees may also be difficult to prove. Moreover, possession of a cash desk may turn out to be an incentive to burglary, or at least be more provocative of a burglary than a bank payment card terminal.

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