Payment Instruments, Financial Privacy and Online Purchases

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Abstract

The protection of financial personal data has become a major concern for Internet users in the digital economy. This paper investigates whether the consumers’ use of non-bank payment instruments that preserve financial privacy from banks and relatives may increase their online purchases. First, we construct a model in which a bank competes with a non-bank institution for consumers who purchase a privacy-sensitive good at an online retailer. We show that the introduction of the payment instrument of the non-bank increases the total demand of online consumers. Secondly, we test this theoretical result by analyzing the purchasing decisions as well as the use of bank and non-bank payment instruments by a representative sample of French Internet consumers in 2015. Using an ordered probit model, we find evidence that using non-bank payment instruments positively influences the frequency of online purchases.

Key Words: Payments, Financial Privacy, Electronic commerce.

JEL Classification: G21, G23, L81, L86.

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1 Introduction

The protection of personal data has become a major concern in the digital economy. Everyday, dozens of newspapers, TV and the online articles and chronicles comment on the development of government surveillance programs, data security breaches at major retailers, the tracking and profiling of consumers, data sharing between businesses, the reform of data protection laws, etc. In reaction, more and more people claim that it is not a good thing for society if Internet users are being watched online, and thus have begun to change the ways they use technologies. For example, a recent survey of the Pew Research Center in 2015 reports that "34% of those who are aware of the surveillance programs have taken at least one step to hide or shield their information from the government; [...] 17% changed their privacy settings on social media; [...] 14% say they speak more in person instead of communicating online or on the phone; and 13% have avoided using certain terms in online communications."

Privacy concerns are not only restricted to traces left during Internet sessions. People are also concerned by the privacy of their financial transactions. For example, debit and credit cards provided by banks are today the main payment instruments used for online purchases. Now, the use of cards leave traces on the consumer’s bank account. These traces are exploited by banks to profile clients and offer them premium financial services or commercial recommendations. Payment history accounts for 35% of the computation of the credit scoring FICO Score, which is used by the majority of financial institutions. For these reasons, consumers can be reluctant to disclose personal data to banks and decide not to shop online. For example, certain consumers do not want to be profiled by banks to avoid to be tracked. Others do not want to be targeted and solicited by unknown businesses. Finally, some consumers simply want to hide information from relatives and from government-related institutions who may access bank statements. To summarize, consumers may be concerned with their financial data for various reasons, and decide

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1 A survey of the Pew Research Center entitled "Public Perceptions of Privacy and Security in the Post-Snowden Era" reports that 62 per cent of respondents do not think it is a good thing for society if people believe they are being watched online.

2 Payment history is the most important component of the FICO score as it is detailed here; last visit: 23/11/2015

3 An article on the Belgium RTBF website in November 2015 relates the story of a researcher that saw a bank transfer from an NGO helping victims of the civil war in Syria blocked by her bank because the word syria appeared in the description of the transaction. It was a legitimate reimbursement of travel expenses, but the bank considered it as a potential attempt at money laundering or funding of terrorist activities. The article can be retrieved at the following address; last visit: 11/12/2015.
not to use bank cards, or other bank payment instruments (checks, etc.) that disclose too much personal data.

To protect their financial data, privacy-minded users may decide to use non-bank payment instruments that are not directly linked to their banking account. For example, a transaction carried out with PayPal cannot be completely tracked by the bank even though the consumer uses his bank card. Similarly, the use of electronic payments systems such as electronic currencies (Bitcoin and other cryptocurrencies) are completely anonymous and disconnected from bank accounts. Such payment services may therefore be used by consumers in online purchases to preserve personal data from banks and relatives. As a consequence, the use of non-bank payment services may allow consumers to purchase online goods that they would not have purchased with bank payment instruments, resulting in an overall positive impact on online purchases.

This paper investigates whether the use of non-bank payment instruments that preserve financial privacy from banks may increase online purchases. We construct a model that analyzes competition between a bank and a non-bank institution that provide a payment instrument to purchase two goods at an online retailer: a standard good and a privacy-sensitive good. Consumers are concerned about the tracking of their financial data by the bank. To model financial privacy concerns, we assume that consumers incur an additional cost when purchasing the privacy-sensitive good using the bank payment instrument. We show that consumers who do not want to purchase with the bank payment instrument for financial privacy concerns can now buy online using the non-bank payment instrument, resulting in an increase of the demand of online consumers. We test this result by analyzing the purchasing decisions as well as the use of bank and non-bank payment instruments by a representative sample of 811 French Internet consumers in 2015. Using an ordered probit model, we find evidence that using non-bank payment instruments positively influence the frequency of purchases.

The article proceeds as follows. Section 2 provides a brief discussion of the relevant literature. Section 3 presents our model of choice of payment instrument and consumption. Section 4 presents the equilibrium strategies. Section 5 describes the data, present the estimation strategy and discuss the estimation results. Section 6 concludes.
2 Related literature

This paper studies how consumers may adopt strategic behaviors when using payment instruments in online purchases to protect their financial privacy from banks and/or relatives. It is at the crossroads of different strands of the literature on the economics of privacy, the economics of payments and information sharing between banks.

First, two papers on the economics of privacy analyze the link between privacy issues and electronic commerce. They confirm that consumers’ privacy concerns negatively affect online purchases. Akhter (2012) analyzes survey data from a sample of 1,097 Internet subscribers in three Midwest states in the United States. The author finds that privacy concern has a negative and statistical significant influence on online spending. Similarly, Tsai et al. (2011) design an experimental study based on a search engine that displays the privacy policies of specific online shopping sites. They test whether participants presented with salient privacy information would be more likely to purchase from sites with privacy indicators than participants who did not see that information. They find that participants provided with salient privacy information took that information into consideration, making purchases from websites offering medium or high levels of privacy. Our paper confirms in part their findings as we find that privacy-minded users purchase less online than the others. However, we also find evidence that online consumers may adopt strategies to protect their privacy from banks and relatives by using non-bank payment instruments, resulting in a positive influence on online purchases.

The literature on the economics of privacy has also considered the use of strategies by consumers to avoid price discrimination (Acquisti et al. (2015)). For instance, Villas-Boas (2004) show that consumers can postpone their purchase to avoid being identified by the price-discriminating firm. Likewise, Conitzer et al. (2012) show that consumers can decide to remain anonymous from the retailer in order to avoid price discrimination. We extend this idea in our paper by showing that consumers may adopt strategies in order to avoid discriminatory practices based on their transaction history by financial institutions (scoring practices and other commercial use of personal data).

A number of other studies have also specifically focus on the effects of financial privacy regulations. In the U.S. for instance, the Gramm-Leach-Bliley Act (GLBA) allows a variety of financial institutions to collect, share and use personal information about their customers. The
GLBA requires financial institutions to provide each consumer with a privacy notice explaining the exploitation of their personal data. The notice must also identify the consumer’s right to opt out of the information being shared with unaffiliated parties. However, there are two main exemptions that authorizes information sharing despite objections from consumers: first it allows an institution to disclose personal information to affiliated institutions without providing notice of the disclosure and an opportunity to opt out; second, it allows an institution to disclose non-public personal financial information to non-affiliated third parties that jointly offer marketing with the original institution. If Lacker (2002) argues that the market for financial privacy has the characteristics that should yield efficient outcomes, Swire (2002) advances that the GLBA could lead financial institutions to review their data exploitation practices and to get rid of those with a low respect of privacy. The GLBA has also drawn criticisms concerning the level of its privacy protection. Janger and Schwartz (2002) for example consider that consumers are not sufficiently informed and that this lack of information reduces their bargaining power with financial institutions. Concerning the impact of the GLBA, Sheng and Cranor (2006) find that the sharing of information about consumers between affiliates and non-affiliates has increased since the adoption of the GLBA. Similarly, Cranor et al. (2013) show that an important number of financial institutions shares consumers’ data without allowing them to limit or to stop data disclosure.

The legislation regarding financial privacy in Europe is less permissive than in the U.S. Financial privacy is regulated by the Data Protection Directive 95/46/ec, which allows financial institutions to collect data about consumer identification data and products and services management, but not to sell or share them with non-affiliates. Financial institutions can share data among affiliates, but not without an authorization by both privacy regulation authorities and consumers. Jentzsch (2007) finds however that financial privacy regulation in Europe does not significantly reduce credit reporting practices. U.S. financial institutions have a more intensive use of credit reporting, but the difference is not imputable to differences in regulation between Europe and the U.S. Our analysis does not directly deals with the efficiency of financial privacy regulations but show however that consumers are sensitive to financial privacy concerns and that prohibiting banks to communicate financial information with non-affiliates allow precisely strategic consumers to shop more often online.

This paper is also related to the literature on information sharing in credit markets. Pagano and Japelli (1993) showed that information sharing between lending institutions helps decreasing
adverse selection, a decrease that can take the form of a lower amount of loans to risky borrowers (Hertzberg et al. (2011)). Information sharing also yields an increase in the effort of potential borrowers (Padilla and Pagano (1997) and Padilla and Pagano (2000)), but also lower competition in the market (Bouckaert and Degryse (2006)). Karapetyan and Stasescu (2014) show that this lower competition can lead to higher information acquisition in the credit market. Recently, Kim and Wagman (2015) argue that consumer information exchange in financial markets can lead to lower prices for consumers and to higher screening of financial products applicants, which induces an increase in ex-ante social welfare. Shy and Stenbacka (2015) analyze how firms make higher profits in weak privacy protection, that is the inability to share consumer information with other firms, than with the absence or strong privacy protection. Our paper differs from theses studies in that we analyze information acquisition by financial institutions, but from the perspective of the consumers, that is their willingness to let financial institutions access their online purchases history.

Finally, our paper is also linked to the literature about the choice of payment instruments, a choice that can be affected by anonymity. While Markose and Loke (2003) suggest that there is a perfect substitution between cash and card payments, Drehmann et al. (2002) argue that the fact that cash preserves anonymity makes card payments not a perfect substitute. Using survey data about the German payment behavior, von Kalckreuth et al. (2014) find that the anonymity permitted by a payment instrument explains its adoption. Anonymity is also a key feature of payment instruments such as Bitcoin. According to Kahn and Linares-Zegarra (2015), this desire for anonymity could in part be explained by the risk of identity theft. We show in this paper that consumers may want to choose payment instruments more respectful of their financial privacy for other reasons that identity theft, mainly for keeping banks and relatives from having access to their transaction history.4

3 Model

We construct a model in which consumers can use a non-bank payment instrument that protects their personal data from banks. We analyze how the introduction of a non-bank payment instrument affects the purchasing decisions of consumers. First, we define the objective functions of

4The social consequences of surveillance by relatives and friends are studied by sociologists such as Castells (2001).
consumers, of the financial intermediaries and of the retailer. We also define the timing of the game. Secondly, we analyze the equilibrium strategies. Finally, we comment on the results of the model.\footnote{We could have used a two-sided market model in order to modelize cross-side network effects. However, as we only have one retailer that proposes the two payment systems (mulit-homing), this would not add any further insights.}

3.1 Consumer preferences and demand functions

Consumers have financial privacy concerns. They do not necessarily want to disclose personal data to financial intermediaries when using payment instruments. In the model, consumers are supposed to be uniformly distributed over a unit line according to their sensitivity to financial privacy \((x \in [0, 1])\). They can purchase two goods (indexed by \(i = \{1, 2\}\)) at a price \(p_i > 0\) using a payment instrument \(k\) offered either by a bank \((b)\) or a non-bank \((a)\) (indexed by \(k = \{a, b\}\)). A non-bank institution can be an online financial intermediary such as Paypal.\footnote{Consumers have unit demands (separately) for goods 1 and 2}

Buying online and using a payment instrument provides a direct utility related to the valuation of the good \((v_i)\) but also involves a cost \((c)\) due to the disclosure of personal data to financial intermediaries. We assume that \(v_2 > v_1\), which translates the fact the first good is the outside option for which there is no privacy concern, and the second good has a higher value but is also associated with privacy concerns. We also assume that \(c\) is the same when using the payment instrument offered by \(a\) or \(b\) for good 1. When purchasing good 2, the consumer supports an additional cost \(\alpha\) \((\alpha \in [0, 1])\) if she uses the payment instrument provided by the bank. Consumers are therefore more concerned by privacy issues when purchasing good 2 using the card provided by the bank. The utility functions of consumers are given by equations (1)-(2).

For good 1:

\[
U_1 = \begin{cases} 
  v_1 - p_1 - cx - f_b & \text{if she uses (b),} \\
  v_1 - p_1 - cx - s & \text{if she uses (a),} \\
  0 & \text{if she does not buy the good.} 
\end{cases} \tag{1}
\]

For good 2:

\[
U_2 = \begin{cases} 
  v_2 - p_2 - c(1 + \alpha)x - f_b & \text{if she uses (b),} \\
  v_2 - p_2 - cx - s & \text{if she uses (a),} \\
  0 & \text{if she does not buy the good,} 
\end{cases} \tag{2}
\]
where \( f^b \) is the fee charged by the bank to use the payment instrument \((b)\), and \( s \) the cost of using the alternative payment instrument \((a)\). The cost \( s \) of using the non-bank payment instrument includes, among other things, the technical cost associated with the inconvenience and the technical difficulties of using online payment tools.

We analyze two market structures. First, we study the case in which the bank is in monopoly position. Consumers purchase goods 1 and 2 using the payment instrument offered by the bank \((b)\). In the second market structure, consumers can choose between the two payment instruments provided by the non-bank and by the bank. Consumers who are highly concerned with financial privacy will not purchase at all, while consumers with no privacy concern will purchase using the bank payment system. Consumers with an intermediate level of privacy concern buy using the non-bank payment instrument.

**Monopoly**

The demand faced by the retailer \((r)\) using the bank payment instrument is constructed from the segment of consumers who have strictly positive utility of purchasing the goods. The consumer who is indifferent between purchasing or not good 1 is determined by the following expression:

\[
\hat{x}^{b,m}_1 = \frac{v_1 - p_1 - cx - f^{b,m}}{c}.
\]

Similarly, the indifferent consumer between purchasing or not good 2 is determined by:

\[
\hat{x}^{b,m}_2 = \frac{v_2 - p_2 - f^{b,m}}{c(1 + \alpha)}.
\]

The retailer and the bank face the same aggregate demand:

\[
d^{b,m} = D^{b,m} = d^{b,m} = D^{b,m} = \hat{x}^{b,m}_1 + \hat{x}^{b,m}_2 = \frac{v_1 - p_1 - f^{b,m}}{c} + \frac{v_2 - p_2 - f^{b,m}}{c(1 + \alpha)}.
\]

**Duopoly**

For each good, the demands for the bank and for the non-bank are determined by two indifferent consumers: the consumer who is indifferent between purchasing using the non-bank
payment system or not purchasing at all; the consumer who is indifferent between purchasing the good using payment instrument \( a \) or \( b \).

We show in Appendix 1 that \( f^b \) is necessarily lower than \( s \) at the equilibrium of the game\(^7\). In this case \((a)\) is always dominated by \((b)\) and the consumer who is indifferent between purchasing or not good 1 using the bank payment system is determined by the following expression:

\[
v_1 - p_1 - cx - f^{b,d} = 0, \\
\hat{x}^{b,d}_1 = \frac{v_1 - p_1 - f^{b,d}}{c}.
\]

For good 2, the indifferent consumer between using \( b \) or \( a \) is given by:

\[
v_2 - p_2 - c(1 + \alpha)x - f^{b,d} = v_2 - p_2 - cx - s, \\
\hat{x}^{a,b,d}_2 = \frac{s - f^{b,d}}{c\alpha}.
\]

The indifferent consumer between purchasing or not good 2 is determined by:

\[
v_2 - p_2 - cx - s = 0, \\
\hat{x}^{a,d}_2 = \frac{v_2 - p_2 - s}{c}.
\]

The retailer faces the aggregate demand, while the two financial intermediaries face their individual demands:

\[
d^{r,d} = d^{r,d}_1 + d^{r,d}_2 = \hat{x}^{b,d}_1 + \hat{x}^{a,d}_2 = \frac{v_1 - p_1 - f^{b,d}}{c} + \frac{v_2 - p_2 - s}{c},
\]

\[
d^{b,d} = d^{b,d}_1 + d^{b,d}_2 = \hat{x}^{b,d}_1 + \hat{x}^{a,b,d}_2 = \frac{v_1 - p_1 - f^{b,d}}{c} + \frac{s - f^{b,d}}{c\alpha},
\]

\[
d^{a,d} = d^{a,d}_2 = \hat{x}^{a,d}_2 - \hat{x}^{a,b,d}_2 = \frac{v_2 - p_2 - s}{c} - \frac{s - f^{b,d}}{c\alpha}.
\]

\(^7\)There is an other case where the bank can capture the overall demand by setting low fees, which prevent the non-bank from entering the market. We do not analyze this particular case as it would not bring any additional insight to our model.
3.2 The retailer

The retailer respectively charges prices \( p_1 \) and \( p_2 \) for good 1 and 2, and proposes both payment instruments. The retailer pays a fee \( g^k \) if consumers purchase a good using the payment instrument. For each transaction, the bank charges a fee \( f^b \) to consumers, and a fee to the retailer \( g^b \).

The profit of the retailer is:

$$\Pi^r(p_i) = \sum_i d_i^b(p_i - g^b) + \sum_i d_i^a(p_i - g^a).$$

Under the monopoly case, we obtain:

$$\Pi^r(p_i) = x_1^{b,m}(p_1 - g^{b,m}) + x_2^{b,m}(p_2 - g^{b,m}),$$

$$= \left( \frac{v_1}{c} - \frac{f^{b,m}}{c} \right)(p_1 - g^{b,m}) + \left( \frac{v_2}{c(1 + \alpha)} \right)(p_2 - g^{b,m}).$$

Under the duopoly case, we obtain:

$$\Pi^r(p_i) = \hat{x}_1^{b,d}(p_1 - g^{b,d}) + \hat{x}_2^{a,b,d}(p_2 - g^{b,d}) + \left( \hat{x}_2^{a,d} - \hat{x}_2^{a,b,d} \right)(p_2 - g^{a,d}),$$

$$= \left( \frac{v_1}{c} - \frac{f^{b,d}}{c} \right)(p_1 - g^{b,d}) + \left( \frac{s - f^{b,d}}{c\alpha} \right)(p_2 - g^{b,d}) + \left( \frac{v_2}{c} - \frac{s}{c\alpha} \right)(p_2 - g^{a,d}).$$

3.3 Financial intermediaries

The profit functions of the financial intermediaries differ with respect to the market structure.

The profit of the bank is:

$$\Pi^b(f^b, g^b) = \sum_i d_i^b(f^b + g^b).$$

When the bank is in a monopoly position, the demand is given by \( d^{b,m} = (\hat{x}_1^{b,m} + \hat{x}_2^{b,m}) \):

$$\Pi^{b,m}(f^{b,m}, g^{b,m}) = \left( \hat{x}_1^{b,m} + \hat{x}_2^{b,m} \right)(f^{b,m} + g^{b,m}),$$

$$= \left( \frac{v_1}{c} - \frac{f^{b,m}}{c} \right)(f^{b,m} + g^{b,m}).$$

When the bank and the non-bank compete, the demands that the bank faces are \( d_1^{b,d} \) and \( d_2^{b,d} \) and the profit of the bank is:

$$\Pi^{b,d}(f^{b,d}, g^{b,d}) = \left( \hat{x}_1^{b,d} + \hat{x}_2^{a,b,d} \right)(f^{b,d} + g^{b,d}),$$

$$= \left( \frac{v_1}{c} - \frac{f^{b,d}}{c} + \frac{s - f^{b,d}}{c\alpha} \right)(f^{b,d} + g^{b,d}).$$
The profit of the non-bank is:

\[ \Pi^{a,d} = \sum_i d^{a,d}_i \cdot g^{a,d}. \]

The non-bank is only operating in the duopoly market structure, and makes no profits on good 1 given that \( f^b < s \). The demand faced by the non-bank is \( d^{a,d}_2 \) and the profit is:

\[
\Pi^{a,d}(g^{a,d}) = \left( \hat{x}_2^{a,d} - \hat{x}_2^{a,b,d} \right) g^{a,d},
\]

\[
= \left( \frac{v_2 - p_2 - s}{c} - \frac{s - f^{b,d}}{c\alpha} \right) g^{a,d}.
\]

### 3.4 Timing of the game

The timing of the game is in three steps:

Stage 1: Financial intermediaries set \( f^b \), \( g^b \) and \( g^a \).

Stage 2: The retailer charges \( p_1 \) and \( p_2 \) for goods 1 and 2 respectively.

Stage 3: Consumers decide whether to purchase the goods or not, and choose the payment instrument.

We solve the subgame perfect equilibria of the games by backward induction.

### 4 Equilibrium strategies

#### 4.1 Monopoly (m)

In the second stage of the game, the retailer maximizes its profit function (concave in \( p_1 \) and \( p_2 \)), which leads to the optimal prices:

\[
\frac{\partial \Pi^{r,m}}{\partial p_1^m} = 0 \Rightarrow p_1^{m*} = \frac{v_1 + g^{b,m} - f^{b,m}}{2},
\]

\[
\frac{\partial \Pi^{r,m}}{\partial p_2^m} = 0 \Rightarrow p_2^{m*} = \frac{v_2 + g^{b,m} - f^{b,m}}{2}.
\]

In the first stage of the game, the monopoly maximizes its profit function with respect to its fees \( f^{b,m} \) and \( g^{b,m} \). However, it can be simplified to a one variable maximization problem

\[
\frac{\partial \Pi^{b,m}}{\partial (f^{b,m} + g^{b,m})} = 0 \Rightarrow (f^{b,m} + g^{b,m})^* = \frac{v_2 + (\alpha + 1)v_1}{2(\alpha + 4)}
\]
The demands of the retailer and the bank are similar. We then have:

\[ d_{r,m}^* = d_{b,m}^* = \frac{(3 + \alpha)v_1 - v_2}{4(\alpha + 2)c}, \]

\[ d_{r,m}^* = d_{b,m}^* = \frac{(2\alpha + 3)v_2 - (1 + \alpha)v_1}{4(\alpha + 1)(\alpha + 2)c}, \]

\[ D_{\text{total}}^m = d_{r,m}^* + d_{r,m}^* = \frac{v_2 + (\alpha + 1)v_1}{4c(\alpha + 1)} \]

which leads to:

\[ \Pi_{b,m}^* = \frac{((1 + \alpha)v_1 + v_2)^2}{8c(1 + \alpha)(2 + \alpha)}, \]

**Proposition 1:** \( \frac{\partial (f_{b,m}^* + g_{b,m}^*)^*}{\partial \alpha} = \frac{v_1 - v_2}{(\alpha + 2)^2} < 0 \)

Proposition 1 shows that the total fee charged by the bank to consumers decreases with the additional cost \( \alpha \) related to financial privacy. The bank prefers to decrease the fees to compensate for the increased concerns for privacy. The rate at which the fee decreases with \( \alpha \) increases with the value of the privacy-sensitive good.

### 4.2 Duopoly (d)

The aggregate demand is \( D_1 = d_{b,d}^* \) and \( D_2 = d_{a,d}^* + d_{b,d}^* \). In the second stage of the game, the retailer maximizes its profit function which leads to the optimal prices:

\[ \frac{\partial \Pi_{r,d}^*}{\partial p_1^d} = 0 \Rightarrow p_1^d = \frac{v_1 + g_{b,d} - f_{b,d}}{2}, \]

\[ \frac{\partial \Pi_{r,d}^*}{\partial p_2^d} = 0 \Rightarrow p_2^d = \frac{v_2 - s + g_{a,d}}{2}. \]

In the first stage of the game, both financial intermediaries maximize their respective profit function. The bank profit is maximize at \( (f_{b,d}^*, g_{b,d}^*) \) where

\[ f_{b,d}^* = 0 \]
and

\[ g_{b,d}^* = \frac{\alpha v_1 + 2s}{2\alpha} \]

(see the Appendix for a complete analysis).

In response, the fee practiced by the non-bank is:

\[ \frac{\partial \Pi_{a,d}}{\partial g_{a,d}} = 0 \Rightarrow g_{a,d}^* = \frac{\alpha v_2 - (2 + \alpha)s + 2f_{b,d}}{2\alpha} = \frac{\alpha v_2 - (2 + \alpha)s}{2\alpha}, \]

The equilibrium demands faced by the financial intermediaries and the retailer are the following:

\[ d_{b,d}^* = D_2^d = \frac{\alpha v_1 - 2s}{4\alpha c}, \]
\[ d_{a,d}^* = \frac{s}{\alpha c}, \]
\[ d_{a,d}^* = \frac{\alpha v_2 - (\alpha + 2)s}{4\alpha c}, \]
\[ D_2^d = d_{a,d}^* + d_{b,d}^* = \frac{\alpha v_2 - \alpha s + 2s}{4\alpha c}, \]
\[ D_{total}^d = \frac{v_1 + v_2 - s}{4c} \]

which leads to:

\[ \Pi_{b,d}^* = \frac{(\alpha v_1 + 2s)^2}{8\alpha^2 c}, \]
\[ \Pi_{a,d}^* = \frac{(\alpha v_2 - \alpha s - 2s)^2}{8\alpha^2 c}, \]

**Proposition 2:** \( \frac{\partial g_{b,d}^*}{\partial \alpha} < 0 \) and \( \frac{\partial g_{a,d}^*}{\partial \alpha} > 0 \)

\[ \frac{\partial g_{a,d}^*}{\partial \alpha} = \frac{s}{\alpha^2} = -\frac{\partial g_{b,d}^*}{\partial \alpha} \]

Competition drives the bank to decrease \( g_{b,d} \) when \( \alpha \) increases. Increasing \( \alpha \) benefits the non-bank as the bank is more penalized by financial privacy concerns.
4.3 Results and comparison

We analyze whether the introduction of a non-bank payment instrument increases the demand for good 2 as well as the aggregate demand. To do so, we compute the difference between the demand for good 2 under the monopoly and under the duopoly.

Denoting $D_{total}^m$ the total demand for all goods in the monopoly case and $D_{total}^d$ the demand in the duopoly case, we have:

**Proposition 3:** $D_{total}^d > D_{total}^m$ (proof: see Appendix 2).

The increase in total demand result from two opposite economic forces according to the value of $\alpha$, $s$, $v_1$ and $v_2$: a positive market expansion effect and a negative competition effect.

A strong market expansion effect arises when the cost $\alpha$ associated to financial privacy is large enough. In that case, the demand for good 2 is always greater under duopoly than under monopoly. When $\alpha$ is large and the value $v_2$ of good 2 is also large, the demand for good 1 under duopoly also increases\(^8\): as the competition becomes tougher on the market for good 2, the fees set by the bank decreases.

For high values of $\alpha$ and a small market for good 2, the bank will focus on the market for good 1 by increasing its fees, which reduces demand. However, overall, the aggregate demand for good 1 and good 2 still increases, as the increase in the demand for good 2 is greater than the reduction of the demand for good 1.

A large value of the cost $s$ of using the non-bank payment instrument also increases the demand for good 2 under duopoly, as it increases the demand for good 2 using the bank payment instrument more than it decreases the demand using the non-bank payment instrument.

When the cost $\alpha$ associated with financial privacy is small, the competition effect becomes stronger. The demand for good 2 is larger under duopoly than under monopoly when the value $v_1$ of good 1 and the cost $s$ to use the non-bank payment instrument are large. However, the demand for good 1 decreases under duopoly for large values of $v_1$ and of $s$. Indeed, demand for good 1 under monopoly is more sensitive to an increase in $v_1$ and $s$ than the demand for good 1 under duopoly: without competition, the bank has less constraints to set its fees. Nevertheless,

\(^8\) $v_2$ has a negative effect on the demand for good 1 in the monopoly case, but not under duopoly.
the aggregate demand is always larger under duopoly than under monopoly for small values $\alpha$, as the increase in the demand for good 1 more than compensates the decrease in the demand for good 2.

5 Empirical investigation

In this section, we test whether the use of a non-bank payment instrument has a positive impact on online purchases. We first present the survey used to collect the data. Second, we use descriptive statistics to document the main research questions of the paper. Third, we describe the estimation strategy and define the variables used in the regressions. Finally, we discuss the estimation results.

5.1 Survey design

We use a survey carried out in May 2015 by ACSEL/Caisse des Dépôts on a sample of 1,000 French Internet users aged 18 and over and representative of the French Internet population (in terms of age, sex, socioeconomic classification, urban areas and Internet use). The survey has been conducted using online questionnaires.
The main objective of the survey is to measure the level of trust of Internet users in several online services (bank, administration, etc.). The survey is divided into several sections that deal with Internet access and use, e-commerce, payment instruments, online banking, online communication (chats, blogs, etc.), social networks, online administration, cloud services, Internet of things, security and authentication, personal data and privacy.

We focus our empirical study on the questions related to e-commerce (frequency of purchase, average monthly spending, trust in online retailers, security and privacy policy, etc.) and online payments. We now describe these questions in more detail.

5.2 Descriptive statistics

French e-commerce is one of the most developed in Europe. In 2014, 34.7 millions of online consumers (79 per cent of french Internet users) spent 57 billion euro in 164,000 online retailers. In our survey, 81 per cent of the respondents (811 respondents) in 2015 report to have made at least one online purchase during the last 12 months. Figure 1 displays the distribution of the frequencies of online purchases. The two modes of the distribution are "less often than once a month" (39 per cent) and "one or two times a month" (27 per cent). Overall, 40 per cent of the online consumers claim to make more than one purchase a month.

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9Chiffres cles 2015, FEVAD, 2015
Consumers use several payment instruments (Figure 2) for their online purchases. Payment cards provided by banks and PayPal are by far the two most used payment instruments: 94 per cent declare using a payment card, and 35 per cent PayPal. We also observe that 22 per cent of the respondents use other payment instruments such as gift cards that are redeemable only for purchases at retailers and that cannot be cashed out.

---

10.95 per cent of the payment cards issued in France are debit cards (see Bagnall et al. (2015)).
11. As from April 2015, 165 million of PayPal accounts are active with an average of 23 transactions by account in the first quarter of 2015. At the end of March 2015, 30 per cent of US online transactions were made using PayPal (retrieved from Paypal.com).
Among online consumers, 53 per cent only use one payment instrument, 29 per cent use two payment instruments, and 18 per cent use three or more payment instruments. Internet users who only use one payment instrument prefer bank payment cards (94 per cent), while only two per cent of them prefer PayPal. People using two or more payment instruments, prefer bank payment cards and PayPal (66 and 58 per cent, respectively). The use of the other payment instruments is limited. It is worth noting for our purpose that PayPal is not accepted by all retailers in France, which explains its limited rate of penetration. For instance, Amazon does not accept PayPal transfers. However, a retailer who accepts PayPal always accepts a bank payment card, since is not yet used by all consumers and that transaction fees are above 1.9 per cent and can reach 3.4 per cent for transactions prices below 2500 EUR in France. Therefore, using PayPal is a choice that a consumer makes even though the bank card is accepted.

To summarize, consumers can use payment instruments provided by banks such as payment cards, checks, and credit transfers that are related to their bank account as well as non-bank pay-
ment instruments provided by companies such as PayPal, operator billing, private label cards, prepaid cards, and digital currencies. In Figure 3, we note that 54 and 2 per cent of the respondents report that they exclusively use bank or non-bank payment instruments, and 24 per cent report that they use both bank and non-bank payment instruments. Consumers therefore use non-bank payment instruments in addition to bank payment instruments.

Figure 3: Exclusive use of bank and non-bank payment instruments

These preliminary descriptive statistics raise the question of the motivation of consumers to use non-bank payment instruments for their online purchases. In this paper, we hypothesize that they use in part non-bank payment instruments to protect their financial privacy. Indeed, using a bank payment instrument leaves a trace on the bank account such as the

\[12\] Consumers also report that they use another payment instrument, which includes gift certificates and most likely cash transactions on websites such as Leboncoin.fr, a classified ads website

\[13\] Convenience, security and person-to-person transfers are further characteristics that could also explain the use of non-bank payment instruments. We control for these factors in the estimation procedure.
name of the retailer, the amount of the transaction, its date, etc. By contrast, using a non-bank payment instrument does not necessarily leave a trace on the bank statement. For example, when using PayPal, Internet users have two options. First, they can decide to credit their online PayPal account, which allows them to directly pay online. In that case, banks have absolutely no information on online purchases. Second, they can decide to register and to use the card provided by the bank. In that case, all payments made using PayPal are reduced to a single line on the bank account and banks have only the aggregate amount of online payments carried out on a given period, but not the characteristics of each payment. Likewise, prepaid cards, virtual currencies and the payment services provided by operators (operator billing) cannot be tracked by banks.

Internet users are aware of the characteristics of the payment instruments provided by banks and non-banks. They may decide, for various reasons, to purchase online goods using non-bank payment services to protect personal information from further uses by the banks. For example, some Internet users may want to avoid to be profiled or targeted by financial commercial campaigns. Others may be simply unwilling to let relatives access financial information on a bank statement. Regardless of the reason, consumers may purchase online goods that they would not have purchased using a bank payment instrument if they have the option to use a non-bank payment instrument that protect their financial privacy. To sum up, individual demands may increase with the use of non-bank payment instruments.

To assess the sensitivity of the respondents to privacy issues, we study the way that exclusively users of bank and non-bank payment instruments protect their personal data on the Internet. Interestingly, we observe in Figure 4 that privacy concerns are more important for people who use non-bank payment services than for the people who use exclusively bank payment instruments. Respondents who use non-bank payment services clear their browsing history and cookies more often, and use more ad-blockers and privacy enhancing browser extensions than respondents who use exclusively bank payment instruments. Consequently, respondents who use non-bank payments services care more about the exploitation of their personal data on the Internet and react by using privacy protection tools.

This situation can be compared to the use of cash in point-of-sale transactions. Cash is anonymous and cannot be tracked by banks.
Figure 4: Use of bank and non-bank payment instruments and use of privacy enhancing technologies

This privacy-related behavior also influences online purchases. Figure 5 confirms the intuition that respondents who report to use non-bank payment services shop more frequently online than respondents who only use bank payment instruments. This supports the idea that non-bank payment services allow consumers to purchase online goods that they would not have purchased with bank payment instruments.
5.3 Regression

We test whether the use of non-bank payment instruments, when controlling for various other effects, positively influences online purchases of consumers.

The dependent variable is the frequency of online purchasing: "less often than once per month", "more than once per month", "once per week" and "several times per week". Six classes of explanatory variables are used in the regression. First, we use a binary variable that indicates whether a consumer uses a non-bank payment instrument. As suggested in the theoretical model, we expect to find that the use of a non-bank payment instrument that preserves financial privacy increases online purchases.

Second, some consumers may prefer to use non-bank payment instruments for other reasons such as convenience and efficacy. For instance, they may store personal financial information on the servers of some retailers in order to save time during the online checkout process. To control
for this effect, we include a variable that determines whether a consumer has stored financial
information online.

Thirdly, we include variables related to privacy concerns but not directly related to financial
privacy concerns: whether she used ad-blockers and privacy enhancing web browser extensions
(Ghostery or HTTPS everywhere for example). This type of variables has been used by Akhter
(2012) and Tsai et al. (2011)

Fourth, we include variables related to the risks of electronic commerce: whether the respon-
dent deleted cookies during the past year, the perceived risk of banking details being hacked
on electronic commerce websites, the perceived risk of banking details being consulted by third
parties on online banking websites. We expect these variables to be negatively correlated with
the frequency of purchase.

Fifth, we control for the level of online activities of the respondents: the number of payment
instruments used for online purchases, whether they connect to the Internet every day, the number
of passwords used to secure online accounts (1 = more than 10, 0 = less than 10), average
spendings online (less than 50 EUR, between 50 EUR and 250 EUR), and whether they use
online banking.

Finally, we use several other control variables: whether the respondant has children or not, the
socio-economic category (1=employed, worker or farmers, 0 = other categories), age category
(15-24 y.o., 25-34 y.o., 35-49 y.o., more than 50 y.o.), highest diploma obtained (no diploma,
high school, undergraduate and graduate studies).

5.4 Results and interpretation

We use an ordered probit regression model to explain the frequency of online purchases. Es-
timation results are given in Table 1. In model (1), we restrict the sample to respondents who
only use either bank or non-bank payment instruments, excluding people who use other payment
instruments (such as cash payments on classified ads websites). With respect to this last variable,
we believe that respondents who use other payment instruments mainly use cash to pay transac-
tions done on classified ads websites such as "Leboncoin" in France or "Craigslist" in the US. We
expect this variable to capture the behavior of people who prefer to use cash for transactions and
who are more concerned with their financial privacy and convenience to save cost of shipping.
In model (2), we add other payment instruments among the set of explanatory variables using a binary variable that indicates whether a person has used an other payment instrument.
Table 1: Result estimations

<table>
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<th></th>
<th></th>
<th>OLS</th>
<th></th>
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<td></td>
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<td>Model 2</td>
<td>Model 1</td>
<td>Model 2</td>
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<td>Use of privacy enhancing web browser extensions</td>
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<td>Using many passwords</td>
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<td>0.322**</td>
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<td>Average monthly spending inferior to 50 euros</td>
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<td>–0.729***</td>
<td>–0.420***</td>
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<td>(0.185)</td>
<td>(0.113)</td>
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<td>Average monthly spending between 50 and 250 euros</td>
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<td>(0.186)</td>
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<td>Using online banking</td>
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<tr>
<td><strong>Dependent variable: Frequency of purchase</strong></td>
<td>Model 1</td>
<td>Model 2</td>
<td>Model 1</td>
<td>Model 2</td>
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<td><strong>Individual variables</strong></td>
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<tr>
<td>Having children or not</td>
<td>0.293**</td>
<td>0.296**</td>
<td>0.186***</td>
<td>0.184***</td>
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<td>Lower socioeconomic classification</td>
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<td>Inactives</td>
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<td>15-24 years old</td>
<td>0.405**</td>
<td>0.457***</td>
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<td>(0.0967)</td>
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<td>25-34 years old</td>
<td>0.301*</td>
<td>0.365**</td>
<td>0.157*</td>
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<td>(0.150)</td>
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<td>50 years old and more</td>
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<tr>
<td><strong>Constant</strong></td>
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<td>1.886***</td>
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<td></td>
<td>(0.230)</td>
<td>(0.215)</td>
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<tr>
<td><strong>Constant cut 1</strong></td>
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<td>(0.400)</td>
<td>(0.377)</td>
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<tr>
<td><strong>Constant cut 2</strong></td>
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<td>1.287***</td>
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<td>(0.402)</td>
<td>(0.380)</td>
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<tr>
<td><strong>Constant cut 3</strong></td>
<td>1.910***</td>
<td>2.092***</td>
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<td>(0.408)</td>
<td>(0.387)</td>
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<td><strong>Observations</strong></td>
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<td>630</td>
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<tr>
<td><strong>Pseudo R² - R²</strong></td>
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<td>0.1247</td>
<td>0.2060</td>
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<tr>
<td><strong>LR χ²</strong></td>
<td>130.90</td>
<td>164.20</td>
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<tr>
<td><strong>Prob &gt; χ²</strong></td>
<td>0.000</td>
<td>0.000</td>
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</table>

*Note:*  
*p<0.1; **p<0.05; ***p<0.01
Table 2: Model (1): marginal effects

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<th>Dependent variable: Frequency of purchase</th>
<th>Pr (PF = 1)</th>
<th>Pr (PF = 2)</th>
<th>Pr (PF = 3)</th>
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<td><strong>Payment instruments</strong></td>
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<tr>
<td>Use of non-bank payment instruments</td>
<td>-0.142**</td>
<td>0.71**</td>
<td>0.043**</td>
<td>0.028**</td>
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<td></td>
<td>(0.058)</td>
<td>(0.030)</td>
<td>(0.018)</td>
<td>(0.013)</td>
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<tr>
<td><strong>Convenience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial information stored on e-commerce websites</td>
<td>-0.111***</td>
<td>0.055***</td>
<td>0.034***</td>
<td>0.022***</td>
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<td>(0.034)</td>
<td>(0.018)</td>
<td>(0.011)</td>
<td>(0.008)</td>
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<td><strong>Privacy</strong></td>
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<tr>
<td>Use of ad-blockers</td>
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<td>Use of privacy enhancing web browser extensions</td>
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<tr>
<td>Deleting cookies</td>
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<td>Perceived risk of banking details being hacked on e-commerce websites</td>
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<td>-0.073***</td>
<td>-0.044***</td>
<td>-0.029**</td>
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<td>(0.052)</td>
<td>(0.027)</td>
<td>(0.016)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Perceived risk of banking details being consulted on online banking websites</td>
<td>0.077**</td>
<td>-0.038**</td>
<td>-0.023**</td>
<td>-0.015**</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.017)</td>
<td>(0.011)</td>
<td>(0.007)</td>
</tr>
<tr>
<td><strong>Online activity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of payment methods used</td>
<td>0.022</td>
<td>-0.011</td>
<td>-0.0066</td>
<td>-0.0043</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.024)</td>
<td>(0.014)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Daily use of the Internet</td>
<td>-0.091**</td>
<td>0.045**</td>
<td>0.027**</td>
<td>0.018**</td>
</tr>
<tr>
<td></td>
<td>(0.040)</td>
<td>(0.020)</td>
<td>(0.013)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Using many passwords</td>
<td>-0.094**</td>
<td>0.047**</td>
<td>0.028**</td>
<td>0.019*</td>
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<td></td>
<td>(0.045)</td>
<td>(0.023)</td>
<td>(0.014)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Average monthly spending inferior to 50 euros</td>
<td>0.223***</td>
<td>-0.111***</td>
<td>-0.067***</td>
<td>-0.044***</td>
</tr>
<tr>
<td></td>
<td>(0.063)</td>
<td>(0.033)</td>
<td>(0.021)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Average monthly spending between 50 and 250 euros</td>
<td>0.022</td>
<td>-0.011</td>
<td>-0.0066</td>
<td>-0.0043</td>
</tr>
<tr>
<td></td>
<td>(0.062)</td>
<td>(0.031)</td>
<td>(0.019)</td>
<td>(0.012)</td>
</tr>
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<td>Using online banking</td>
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<td>0.020</td>
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<td>0.0078</td>
</tr>
<tr>
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<td>(0.058)</td>
<td>(0.030)</td>
<td>(0.018)</td>
<td>(0.012)</td>
</tr>
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<td><strong>Individual variables</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Having children or not</td>
<td>-0.097**</td>
<td>0.048**</td>
<td>0.029**</td>
<td>0.019**</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
<td>(0.020)</td>
<td>(0.013)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Lower socioeconomic classification</td>
<td>0.043</td>
<td>-0.021</td>
<td>-0.013</td>
<td>-0.008</td>
</tr>
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<td></td>
<td>(0.045)</td>
<td>(0.023)</td>
<td>(0.014)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Inactives</td>
<td>0.042</td>
<td>-0.020</td>
<td>-0.012</td>
<td>-0.009</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.022)</td>
<td>(0.013)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>15-24 years old</td>
<td>-0.034**</td>
<td>0.067**</td>
<td>0.040**</td>
<td>0.026**</td>
</tr>
<tr>
<td></td>
<td>(0.058)</td>
<td>(0.030)</td>
<td>(0.018)</td>
<td>(0.013)</td>
</tr>
<tr>
<td>25-34 years old</td>
<td>-0.099*</td>
<td>0.050*</td>
<td>0.030*</td>
<td>0.020*</td>
</tr>
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<td></td>
<td>(0.053)</td>
<td>(0.027)</td>
<td>(0.016)</td>
<td>(0.011)</td>
</tr>
<tr>
<td>50 years old and more</td>
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<td>-0.009</td>
<td>-0.0054</td>
<td>-0.0035</td>
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<td>(0.047)</td>
<td>(0.023)</td>
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<td>(0.009)</td>
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<tr>
<td>Education level</td>
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<td>-0.0017</td>
<td>-0.0011</td>
<td>-0.0007</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.011)</td>
<td>(0.007)</td>
<td>(0.0045)</td>
</tr>
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</table>
We find that, all other things being equal, individuals who use non-bank payment instruments purchase online more frequently. Coefficients associated with the variable "Use of non-bank payment instruments" are highly significantly positive in both specifications. There also is an important partial effect on the people who purchase infrequently (less than once per month). This confirms our main research hypothesis that resulted from Proposition 3 of the theoretical model: the availability of a non-bank payment instrument, which protects financial privacy, increases individual and total demand online.

Coefficients estimated in model (1) and those estimated in model (2) are similar. Coefficients associated with age show that younger respondents having a higher propensity to purchase more frequently online, this effect being stronger in model (2). The coefficient of use of other payment instruments is slightly but non significantly positive. Indeed, some people who use cash payments for classified ads also do so to protect their financial privacy.

We have used several variables to control for the different factors that might increase the use of non-bank payment instruments. Amongst them, the convenience of using online payment systems (measured by the variable that determines whether a consumer has stored financial information online) is strongly positive, which shows that it was therefore important to capture this (efficacy) dimension of online payment systems that is not related to financial privacy.

The estimated effects of using privacy-enhancing technologies on the frequency of purchases deserve some discussion. The existing literature suggests that people who are more concerned with their privacy online have a tendency to purchase less online. Our results suggest that the mechanism is more subtle. The coefficients associated with the variables use of privacy enhancing browser extensions have a positive impact on online purchases, which means that as people become more familiar with privacy issues and start to adopt privacy enhancing tools, they start to trust e-commerce more and also to purchase more. This effect is stronger in model (2) than in model (1). However, variables related to the perceived risk of using online payment instruments have a negative and significant effect on the frequency of online purchases. There are probably two types of Internet users. On the one hand, there are people who are afraid of making online transactions and reduce therefore their online purchases. On the other hand, there are Internet users who adopt protection technologies and who trust e-commerce more and increase their online purchases. These two effects should be investigated further.
6 Conclusion

Our results clearly show that Internet users do not necessarily wish to be identified by the bank during all their online activities. They are ready to take actions to hide some of their purchases from the bank or relatives. Doing so increases their online purchases. This finding has two main implications.

First, there is a recent trend by large financial institutions and ‘Fintech startups’ to propose more personalized payment solutions such as personalized coupons. We believe that financial intermediaries should think about enlarging their portfolio of online payment instruments to account for different levels of anonymity: perfectly identification when paying local or federal taxes, anonymous transactions when making gifts or purchasing privacy-sensitive goods. This approach could be paralleled to the European EIDAS regulation on electronic transactions that acknowledges the concept of federation of identities and leaves the door open for pseudonymized transactions.

Second, payment instruments and bank accounts provide useful and ongoing information on consumers’ financial statements (overdrafts, revenues, etc.). By analyzing these traces, banks can evaluate the creditworthiness of consumers and the potential risks of lending money. They can also monitor borrowers to mitigate losses due to bad debt. Following (Mester et al., 2007), providing deposit-taking and lending jointly is a capital advantage for banks in the competition with non-bank institutions that do not manage checking accounts. However, the development of non-bank institutions in the domain of payments could seriously affect this competitive advantage. If a significant fraction of consumer payments are carried out with non-bank institutions, banks will have in return less transactions to manage, and hence less information to make lending decisions. In the end, the profitability of banks could be reduced.
References


A Appendix: proofs

Like in the rest of the paper, the appendix is organized as follow. For any component of an equation, subscript denote the type of good (1 or 2). The first superscript denotes the financial intermediary (the bank $b$ and the non-bank $a$) whereas the second superscript denotes the competition situation (monopoly $m$ or duopoly $d$).

For example, $d_{1}^{a,d}$ denotes the optimal demand in good 1 for the non-bank under duopoly situation. $d_{2}^{b,m}$ denotes the demand in good 2 for the bank, under monopoly situation.

A.1 Appendix: $f_{b,d}^{d^{*}} < s$

We can depict different cases regarding the demand of the bank under duopoly:

- $f^{b} > s$ which brings no demand to the bank,
- $f^{b} = s$ which brings no demand to the bank on good 2. Bank and non-bank equally share the demand on good 1,
- $f^{b} < s$ which brings no demand to the non-bank on good 1. Bank and non-bank compete on good 2.

The bank will obviously never choose $f^{b} > s$ as it will generate no profit. It decides between the two other solutions.

$$
\Pi_{b,d}^{d^{*}} = \frac{(\alpha v_{1} + 2s)^2}{8\alpha(\alpha + 2)c}
$$

$$
\Pi_{b,d}^{b,d|f^{b,d} = s} = \frac{(18v_{1} - 4v_{2} - 5s)^2}{2888c}
$$

$$
\Pi_{b,d}^{d^{*}} > \Pi_{b,d}^{b,d|f^{b,d} = s} \iff \frac{(37\alpha v_{1} - 4\alpha v_{2} - 5\alpha s + 38s)(4\alpha v_{2} + \alpha v_{1} + 5\alpha s + 38s)}{2888\alpha^{2}c} > 0
$$

which is positive for $v_{1} > \frac{4\alpha v_{2} + (5\alpha - 38)s}{37\alpha}$. Or the demand for $\Pi_{b,d}^{b,d|f^{b,d} = s}$ is positive for $v_{1} > \frac{4\alpha v_{2} + 5s}{18}$. As the second condition bind the first, we can say that $\Pi_{b,d}^{d^{*}} > \Pi_{b,d}^{b,d|f^{b,d} = s}$.
A.2 Appendix: critical solutions

A.2.1 Critical solution under monopoly

\[ \Pi_{b,m}(f_{b,m}, g_{b,m}) = (g_{b,m} + f_{b,m}) \left( \frac{v_2 - g_{b,m} - f_{b,m}}{2(\alpha + 1)c} + \frac{v_1 - g_{b,m} - f_{b,m}}{2c} \right) \]

In the first stage of the game, the monopoly maximizes its profit function which leads to its optimal fees:

\[ \frac{\partial \Pi_{b,m}}{\partial f_{b,m}} = 0 \Rightarrow f_{b,m}^* = \frac{(1 + \alpha)v_1 + v_2 - 2(\alpha + 2)g_{b,m}}{2(2 + \alpha)} \]
\[ \frac{\partial \Pi_{b}}{\partial g_{b,m}} = 0 \Rightarrow g_{b,m}^* = \frac{(1 + \alpha)v_1 + v_2 - 2(\alpha + 2)f_{b,m}}{2(2 + \alpha)} \]

It appears we have a multiple equilibrias problem which can be simplified to a one variable maximization problem, where \( g_{b,m}^* + f_{b,m}^* = h_{b,m}^* \):

\[ \Pi_{b,d}(f_{b,d}, g_{b,d}) = h_{b,m}^* \left( \frac{v_2 - h_{b,m}}{2(\alpha + 1)c} + \frac{v_1 - h_{b,m}}{2c} \right) \]

\[ \frac{\partial \Pi_{b,m}^*}{\partial h_{b,m}} = 0 \Rightarrow h_{b,m}^* = \frac{(g_{b,m}^* + f_{b,m}^*)}{2(\alpha + 4)} \]

As the second derivative is negative, we have a maximum \( h_{b,m}^* \).

A.2.2 Critical solution under duopoly

\[ \Pi_{b,d}(f_{b,d}, g_{b,d}) = (g_{b,d} + f_{b,d}) \left( \frac{v_1 - g_{b,d} - f_{b,d}}{2c} + \frac{s - f_{b,d}}{\alpha c} \right) \]

In the first stage of the game, both financial intermediaries maximize their respective profit function. The maximization of the bank’s profit function lead to the following critical point:

\[ \frac{\partial \Pi_{b,d}}{\partial f_{b,d}} = 0 \Rightarrow f_{b,d}^* = \frac{\alpha v_1 + 2s}{2} \]
\[ \frac{\partial \Pi_{b,d}}{\partial g_{b,d}} = 0 \Rightarrow g_{b,d}^* = -\frac{\alpha v_1 + 2s}{2} \]

However, we find that \( (f_{b,d}^*, g_{b,d}^*) \) cancel the profit function.
The determinant of the hessian matrix for the bank decision regarding \( g_{b,d} \) and \( f_{b,d} \) is 
\[
D = \left( \frac{\partial^2 \Pi_{b,d}}{\partial f_{b,d} \partial f_{b,d}} - \left( \frac{\partial^2 \Pi_{b,d}}{\partial g_{b,d} \partial f_{b,d}} \right)^2 \right) < 0.
\]
As there is only one critical point and it cancels profit function as a saddle point, we look then for the constrained equilibrium.

\[
\Pi_{b,d}(f_{b,d}, 0)
\]

\[
\Pi_{b,d}(f_{b,d}, 0) = (f_{b,d}) \left( \frac{v_1 - f_{b,d}}{2c} + \frac{s - f_{b,d}}{\alpha c} \right)
\]

\[
f_{b,d}^* = \frac{\alpha v_1 + 2s}{2\alpha + 4} \iff \Pi_{b,d}(f_{b,d}^*, 0) = \frac{(\alpha v_1 + 2s)^2}{8\alpha(\alpha + 2)c}
\]

\[
\Pi_{b,d}(f_{b,d}, \frac{\alpha v_1 + 2s - (\alpha + 2)f_{b,d}}{\alpha})
\]

\[
\Pi_{b,d}(f_{b,d}, \frac{\alpha v_1 + 2s - (\alpha + 2)f_{b,d}}{\alpha}) = 0
\]

\[
\Pi_{b,d}(0, g_{b,d})
\]

\[
\Pi_{b,d}(0, g_{b,d}) = (g_{b,d}) \left( \frac{v_1 - g_{b,d}}{2c} + \frac{s}{\alpha c} \right)
\]

\[
g_{b,d}^* = \frac{\alpha v_1 + 2s}{2\alpha} \iff \Pi_{b,d}(0, g_{b,d}^*) = \frac{(\alpha v_1 + 2s)^2}{8\alpha^2c}
\]

\[
\Pi_{b,d}(\frac{\alpha v_1 + 2s - \alpha f_{b,d}}{\alpha}, g_{b,d})
\]

\[
\Pi_{b,d}(\frac{\alpha v_1 + 2s - \alpha f_{b,d}}{\alpha}, g_{b,d}) = 0
\]
As $\Pi^{b,d}(0, g^{b,d*}) > \Pi^{b,d}(f^{b,d*}, 0)$, the solution $f^{b,d*} = 0$ and $g^{b,d*} = \frac{\alpha v + 2s}{2\alpha}$ maximizes the profit function.

The total demand under duopoly for the bank is composed from the demand for the first good and the demand for the second good. The fact that the demand for the second good for the bank is not impacted by the price makes it dependent only from the fee $f^{b,d}$.

The demand for the first good has a monopoly form as the bank is the only payment system on the market for good 1. The bank have two instruments to monetize its demand: $f^{b,d}$ which is the fee per transaction paid by the consumers and $g^{b,d}$ which is the fee per transaction paid by the retailer.

Contrary to the monopoly case, the fees have not symmetrical effect on demand. From that point we can notice that an increase in $f^{b,d}$ have a larger negative impact on the total demand of the bank than $g^{b,d}$. Having two instrument allow the bank to reabsorb the loss from an increase in the first fee with a decrease in the second fee. However, as it is not symmetrical and an increase in $f^{b,d}$ cause more damage on the demand than an increase in $g^{b,d}$, an optimal choice is to set $f^{b,d} = 0$ to limit negative impact on demand and to compensate with a higher $g^{b,d}$.

### A.3 Appendix: proof of proposition 3

$$D^{d}_{total} > D^{m}_{total} \iff \Delta_{total} \equiv \frac{\alpha v_2 - (\alpha + 1)s}{4(\alpha + 1)c} > 0$$

The condition for $d_2^{*} > 0$ is $v_2 > \frac{s(\alpha+2)}{\alpha}$ which insure $D^{d}_{total} > D^{m}_{total}$. We can say that total demand is greater under duopoly than monopoly.

Analyzing the effect in decomposing the total demands, we denote $D^{d}_{2}$ the demand for good 2 in the monopoly case and $D^{d}_{2}$ the demand for good 2 in the duopoly case.

We have the following condition:

$$D^{d}_{2} > D^{m}_{2} \iff \Delta_2 \equiv \frac{\alpha_3 + \alpha_2 - \alpha)v_1 + (\alpha_2 + \alpha)v_2 + (4(\alpha + 1) - \alpha^3 - \alpha^2)s}{4\alpha(\alpha + 1)(\alpha + 2)c} > 0$$
The difference in demand for the first product depends on the value of \( v_1, v_2, \alpha \) and \( s \), which directly impact the size of the total fee \( f^b + g^b \) and by extent the demand for good 2.

A large \( v_1 \) decreases more the monopolistic demand for good 2 than it decreases the duopolistic one, hence increasing \( \Delta_2 \).

A high \( s \) increases the duopolistic demand, therefore increasing \( \Delta_2 \).

The impact of \( v_2 \) is more complex. A high \( v_2 \) would increase more the duopolistic demand than the monopolistic one only if \( \alpha > \frac{\sqrt{5} - 1}{2} \). If this last condition holds, we can say that \( D^d_2 > D^m_2 \).

However, for a lower \( \alpha \), it has to be compensated with high \( v_1 \) and \( s \).

Overall, we can say that for a large \( \alpha \) \( D^d_2 \) is always greater than \( D^m_2 \).

Denoting \( D^m_1 \) the demand for good 1 in the monopoly case and \( D^d_1 \) the demand in the duopoly case, we have the following condition:

\[
D^d_1 > D^m_1 \iff \Delta_1 = \frac{\alpha v_2 - \alpha v_1 - 2s(\alpha + 2)}{4\alpha(\alpha + 2)c} > 0
\]

The difference in demand for the first product depends on the value of \( v_1, v_2, \alpha \) and \( s \), which directly impact the size of the total fee \( f^b + g^b \) and by extent the demand for good 1.

Having a large \( v_2 \) will make the monopolistic total fee increase, and by extent decreases the demand for good 1 under monopoly. Therefore, it increases \( \Delta_1 \).

However, a large \( v_1 \) increases more the duopolistic fee than the monopolistic one, thus decreasing \( \Delta_1 \).

A large \( s \) increases duopolistic fee, therefore decreasing \( \Delta_1 \).

The impact of \( \alpha \) is positive if \( v_2 > v_1 + 2s \).
### Appendix: Descriptive Statistics

#### Table A1: Statistics - Binary variables

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>St. Dev.</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td><strong>Payment instruments</strong></td>
<td></td>
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<td>Use of non-bank payment instruments</td>
<td>722</td>
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<td>0.48</td>
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<td><strong>Convenience</strong></td>
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<td></td>
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<tr>
<td>Financial information stored on electronic commerce websites</td>
<td>811</td>
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<td>0.498</td>
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<td>1</td>
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<tr>
<td>Use of ad-blockers</td>
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<td>0.497</td>
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<td>Use of privacy enhancing web browser extensions</td>
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<td><strong>Risk</strong></td>
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</tr>
<tr>
<td>Deleting cookies</td>
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<td>0.457</td>
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<td>Perceived risk of banking details being hacked on electronic commerce websites</td>
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<td>0.860</td>
<td>0.347</td>
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<td>1</td>
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<tr>
<td>Perceived risk of banking details being consulted by third parties on online banking websites</td>
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<td>0.458</td>
<td>0.498</td>
<td>0</td>
<td>1</td>
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<tr>
<td><strong>Online activity</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using Internet several times every day</td>
<td>1,000</td>
<td>0.641</td>
<td>0.480</td>
<td>0</td>
<td>1</td>
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<tr>
<td>More than 10 passwords</td>
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<td>0.170</td>
<td>0.376</td>
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<tr>
<td>Average monthly spending in electronic commerce inferior to 50 euros</td>
<td>723</td>
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<td>0.492</td>
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<tr>
<td>Average monthly spending in electronic commerce between 50 and 250 euros</td>
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<td>0.500</td>
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<td>Having children</td>
<td>1,000</td>
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<td>Lower socioeconomic classification</td>
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<td>1</td>
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<td>Inactives</td>
<td>1,000</td>
<td>0.40</td>
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<td>1</td>
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<tr>
<td>Being between 15 and 24 years old</td>
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<td>Being between 25 and 34 years old</td>
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<td>0.159</td>
<td>0.366</td>
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<td>1</td>
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<tr>
<td>Being more than 50 years old</td>
<td>1,000</td>
<td>0.397</td>
<td>0.490</td>
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Table A2: Statistics - Frequency of purchase

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<th>More than once per month = 2</th>
<th>Once per week = 3</th>
<th>Several times per week = 4</th>
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<th>Mean</th>
<th>St. Dev.</th>
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<td>316</td>
<td>394</td>
<td>72</td>
<td>29</td>
<td>811</td>
<td>1.77</td>
<td>0.75</td>
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</table>

Table A3: Statistics - Number of payment instruments

<table>
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<th></th>
<th>One = 1</th>
<th>Two = 2</th>
<th>Three or more = 3</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>316</td>
<td>394</td>
<td>72</td>
<td>811</td>
<td>1.77</td>
<td>0.75</td>
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</tbody>
</table>

Table A4: Statistics - Education

<table>
<thead>
<tr>
<th></th>
<th>No diploma = 1</th>
<th>High school diploma = 2</th>
<th>Undergraduate and graduate studies = 3</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>231</td>
<td>253</td>
<td>516</td>
<td>1000</td>
<td>2.285</td>
<td>0.82</td>
</tr>
</tbody>
</table>
## Appendix: Questionnaire

### Table A5: Questions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Question</th>
<th>Modalities</th>
</tr>
</thead>
</table>
| **Payment instruments** | Which payment systems do you usually use when you make online purchases? | 1. Bank card  
2. Private credit card  
3. PayPal  
4. Addition on operator fee  
5. Gift certificates  
6. Checks  
7. Banking transfers  
8. Prepaid cards  
9. Digital currency  
10. Other payment system |
| Number of payment instruments used |                                                                   |            |
| Use of non bank payment instruments (Modalities 2, 3, 4, 8 and 9) |                                                                   |            |
| Use of other payment instruments (Modality 10) |                                                                   |            |
| **Convenience** | Have you registered your banking details on some e-commerce websites, which allows you to avoid giving your bank card number for each purchase? | 1. Yes  
2. No |
| Financial information stored on e-commerce websites |                                                                   |            |
| **Privacy and risk** | Regarding the tracking of your online activity, have you ever... | 1. Looked into your browsing history  
2. Deleted cookies and other temporary Internet files  
3. Installed an ad blocker  
4. Installed privacy enhancing browser extensions like Ghostery, HTTPS Everywhere, etc.  
5. None of the above |
| Deleting cookies (Modality 2) |                                                                   |            |
| Use of ad-blockers (Modality 3) |                                                                   |            |
| Use of privacy enhancing web browser extensions (Modality 4) |                                                                   |            |
| Perceived Risk of banking details being hacked on e-commerce websites (Modality 4) | According to you, what are the risks of online purchasing? | 1. A bad functioning of the website  
2. The use of personal data for advertising purposes  
3. The risk of no delivery  
4. The risk of bank hacking  
5. The fact that personal data can be stored indefinitely  
6. The fact that personal data can be consulted by someone else  
7. Other risks  
8. No risk |
<table>
<thead>
<tr>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td><strong>Privacy and risk</strong></td>
</tr>
<tr>
<td>Perceived risk of banking details being consulted on banking websites (Modality 2)</td>
</tr>
<tr>
<td><strong>Online activity</strong></td>
</tr>
<tr>
<td>Using Internet several times a day (Modality 1)</td>
</tr>
<tr>
<td>Having more than 10 passwords (Modalities 4 and 5)</td>
</tr>
<tr>
<td>Average monthly spending inferior to 50 euros (Modality 1)</td>
</tr>
<tr>
<td>Average monthly spending between 50 and 250 euros (Modality 2)</td>
</tr>
<tr>
<td>Using online banking (Modalities 1 and 2)</td>
</tr>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>----------</td>
</tr>
</tbody>
</table>
| **Control variables** | In which socioeconomic classification are you? | 1. Farmers  
2. Craftsmen and tradesmen  
3. Business owners  
4. Executives and liberal, artistic or intellectual professions  
5. Public services or business intermediaries and technicians  
6. Employees  
7. Workers  
8. Retired persons  
9. Students  
10. Unemployed persons  
11. Non-working persons |
| Lower socioeconomic classification (Modalities 1, 6 and 7) |  | |
| Inactives (Modalities 8, 9, 10 and 11) |  | |
| **Having children** (Modality 3) | Do you live... | 1. Alone?  
2. In a couple?  
3. In a couple with children?  
4. Other (colocation, etc.) |
| **15-24 years old** | What is your age? | 1. Between 15 and 24 years old  
2. Between 25 and 34 years old  
3. Between 35 and 49 years old  
4. More than 50 years old |
| **25-34 years old** |  | |
| **More than 50 years old** |  | |
| **Education level** | What is your highest diploma? | 1. No diploma, B.E.P.C, C.E.P  
2. C.A.P or B.E.P  
3. Baccalaureate  
5. Higher diploma |