Policy Research Working Paper 9665

Digital Payments and Business Resilience

Evidence in the Time of COVID-19

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WORLD BANK GROUP
Sustainable Development Global Practice Group
May 2021

Policy Research Working Paper 9665

Abstract

During the COVID-19 pandemic, consumers were encouraged to use contactless payments. An important policy question is whether merchants with contactless payment technology are more resilient to an external health shock than those without. Using a matched difference-in-differences setting on unique merchant card-sales transaction data, this study finds that merchants with contactless payment technology increase their card-sales amount (count) on average by 8.3 percent (10.2 percent) compared with merchants without this technology. It also finds evidence that accepting contactless payment during an epidemic shock helps merchants attract more new consumers. Digital payment technology continues to support sales growth, especially for small businesses and new entrepreneurs.

This paper is a product of the Sustainable Development Global Practice Group. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The author may be contacted at ycamara1@worldbank.org.

Digital Payments and Business Resilience: Evidence in the Time of COVID-19

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Key words: Digital payment, COVID-19, Business resilience, Sales growth, Firm-level data.
JEL classification : C21, E21, E42, E61, E62, O33.

*All findings and interpretations in this paper are solely those of the author and do not necessarily represent the views of the World Bank, its Executive Directors, or the countries they represent. This research has been made possible by the collaboration of Groupement des Cartes Bancaires CB, and was conducted within the Research Chair "Digital Finance" under the aegis of the Risk Foundation, a joint initiative by Groupement des Cartes Bancaires CB, la Banque Postale, la CDC, Telecom Paris and University of Paris 2 Panthéon-Assas. I would like to thank David Bounie, Philippe Durand, Simeon Ehui, John W. Galbraith, Katérina Levallois, Loys Moulin, and Samuel Willy for their helpful comments on earlier versions of the paper. i3, CNRS, Telecom Paris, Polytechnique de Paris (yocamara@telecom-paris.fr). The World Bank Group - Sustainable Development Global Practice (ycamara1@worldbank.org).

1 Introduction

COVID-19, a contact-transmitted epidemic that emerged at the end of 2019 worldwide, has lastingly modified and accelerated transformations and daily practices, particularly in the area of payment.[1] It has accelerated the shift away from cash and contact card payments, with shoppers often being encouraged to use contactless in many stores for public health reasons. Even before the pandemic, the popularity of the latest digital payment technologies was on the rise, with more and more people realizing the convenience they offer (Accenture, 2020; Bakkt, 2020; Thales, 2020).

When COVID-19 began to spread in Europe in 2020, consumers and merchants across the countries were faced with radical changes in many aspects of their lives and activities. The pandemic has increased general public and retailer concerns about the risk of coronavirus contamination in cash, resulting in visibly increased card use, with many retailers asking their customers to pay by contactless. In France, for example, although household consumption was strongly affected by the pandemic, the overall amount of payments made by bank cards and cell phones in 2020 was roughly equivalent to that in 2019. At the same time, cash use and withdrawals decreased in 2020 (Cartes Bancaires CB, 2020; European Central Bank, 2020a; INSEE, 2020a).

Thanks to the rapid evolution of financial and digital technologies, new digital payments such as contactless card payments have been growing fast in recent years. Contactless card payment improves the comfort and efficiency of purchases and sales without physical contact as opposed to contact card and cash payments, which can, in turn, increase consumption and sales. However, it is not certain that in a crisis where physical contact is prohibited, having a suitable means of payment that promotes social distancing will contribute to increasing consumption and sales. A natural question, therefore, arises on the benefits of having a digital payment technology available during an epidemic shock (e.g., COVID-19 pandemic). On the other hand, does having the digital payment technology mitigate the impact of a shock by thus increasing the resilience of users? If there is resilience, what are the origins? Is it because digital payment technologies attract more new customers? Or is it simply because of the shift of transactions with other payment methods to digital payment technologies?

This paper addresses these questions by investigating the resilience of merchants with the con-

[1] The coronavirus is a virus that causes diseases ranging from a simple cold to more severe pathologies such as respiratory distress. It is very dangerous and is transmitted by what are called droplets (like sputum): these are invisible secretions that are projected when talking, singing, sneezing, breathing heavily or coughing. Close contact with a sick person is the main mode of transmission of the disease. Contact with unwashed hands or surfaces soiled with droplets is also at risk of contamination. Some transmission also occurs through the air, mainly in a confined space (World Health Organization, 2020).

tactless payment technology to the first and second containment shocks in response to the COVID-19 epidemic in France using a proprietary data set on card-sales transactions from a representative sample of 94,199 merchants of all banks in France.[2] Surprisingly, I find that the lockdown due to the COVID-19 outbreak promote card sales growth of merchants with the contactless payment technology, especially small businesses, and new entrepreneurs. This result suggests that merchants with contactless payment technology are more resilient to epidemic shocks where barrier gestures is required than those still not using contactless payment technology.

By 2020, France was affected by the COVID-19 epidemic. In order to stop the spread of the virus in France, the government imposed the first containment from mid-March to mid-May 2020. In addition, in mid-May 2020, French banks increased the limit for contactless payment from 30 euros to 50 euros in order to reduce physical contact and promote the use of contactless cards instead of contact cards and cash. Following a significant increase in coronavirus contamination and deaths in October 2020, the French authorities decided again to impose a second containment. I use these three staggered shocks to study the resilience of merchants using contactless payment technology and their effects on merchant sales as well as substitution between payment methods.

I estimate a distributed lag model using the shocks as the exogenous event and obtain the impulse response of card sales. My empirical identification strategy relies on the differential benefits of the contactless payment convenience across merchants with similar characteristics. Utilizing all card and mobile payments for 17,376 matched offline merchants from a set of essential sectors during a two-year period of 2019:01 to 2020:12, I document a significant spillover effect in merchant's sales through card payment. My findings are summarized as follows. First, compared to merchants without the latest digital payment technology, merchants with contactless payment technology experienced an average of 8.3 percent (10.2 percent) more monthly card-sales amount (count) in the 10-month period following the first containment in France in March 2020. Prior to the first shock, there is no difference in the card-sales trend between the treatment group and the control group. Second, the adjustment was rapid, with the effect already very pronounced in the period immediately following the month of the first lockout shock and after the month in which the contactless payment limit was increased. Third, I observe a strong effect of shocks for small businesses, new entrepreneurs, and merchants who make small value per transaction like bakeries. Fourth, using the same difference-in-differences specification, I find consistent results that the number of new

[2]These data were made available thanks to a partnership with Groupement des Cartes Bancaires CB, and I exploit the card payments data in accordance with the EU General Data Protection Regulation, in application of Article 89. I use the abbreviation 'CB' to indicate the source of the card payments.

customers (sales from the new customers) increased by 9.7 percent (14 percent) per month more for merchants with contactless technology, and the effect is statistically significant. This result suggests that the positive effect reflects real business growth rather than the substitution effect where consumers simply switch from cash to card payments. Finally, I explore the increase of the contactless payment limit from 30 euros to 50 euros to investigate the substitution between card payments and other means of payment. I find evidence that increasing the digital payment limit accelerates substitution between digital payments and other payment methods including cash. In addition, the increase of the contactless payment limit to 50 euros significantly accelerates the substitution of sales from contact card to contactless card payments.

This paper is, to the best of my knowledge, the first study of how the sales of merchants with the latest digital payment respond to an outbreak and an increase of payment limit relative to the merchants without this technology using firm-level data. It provides a better and more comprehensive understanding of how merchants with the latest payment technology mitigate the impact of epidemic shocks and how the increase in digital payment limit accelerates the substitution between digital payment sales and the sales from the other means of payment. The current paper contributes to the emerging literature on digitization and fintech with the focus on non-cash payment (Fung et al., 2012; Trütsch, 2014; Bachas et al., 2018; Agarwal et al., 2019; Bounie and Camara, 2020). Fung et al. (2012) and Trütsch (2014) use survey data on consumer payment behavior to examine the impact of contactless payments on consumer spending. The authors show that contactless payments increase the spending for debit and credit cards payment and reduce on average the total value and volume of cash usage. Using firm-level transaction data, Agarwal et al. (2019) and Bounie and Camara (2020) investigate the causal impact of digital payment technologies on merchant sales. They find that merchants with the latest digital payment technology significantly increase sales, especially for small merchants and new entrepreneurs. My paper provides novel insight on the real effects of digitization. In particular, the results highlight the positive impact of contactless payment technology, relative to other payment means, on promoting business growth, especially in the time of a global pandemic where barrier gestures is required. My findings suggest that having a new technology (e.g., contactless payment) continues to drive retail traffic and attract new customers (Agarwal et al., 2019). There is little literature that examines the relationship between a merchant's acceptance of new payment technology and its sales. My paper also contributes to the literature on technology innovation acceptance and diffusion and its impact on various economic areas (see among others Doms et al., 1997; Greenwood et al., 1997; Galor and Tsiddon, 1997; Caselli and

Coleman, 2001; Laitner and Stolyarov, 2003; Comin and Hobijn, 2004; Buchak et al., 2018).[3] It is one of several recent studies that investigate the effects of the COVID-19 pandemic (see for instance Alon et al., 2020; Baker et al., 2020; Chiou and Tucker, 2020; Alfaro et al., 2020; Jones et al., 2020; Alber and Dabour, 2020; Jonker et al., 2020; Bounie et al., 2020b; Guerrieri et al., 2020; Piguillem and Shi, 2020; Bounie et al., 2020a).

The rest of the paper flows as follows. Section 2 introduces the institutional background of card payment and the chronology of COVID-19 crisis in France and describes the data and methodology. Results are presented in section 3. Section 4 checks the robustness of the results, and section 5 concludes.

2 Background, Setting, Data, and Methodology

This section provides background information on the card markets, the COVID-19 crisis in France, and my various data sets and estimation strategies. I explain how I use the unique features of card sales transaction data for the study of the response of merchants with the latest payment technology to the COVID-19 pandemic.

2.1 Contactless Payments and the COVID-19 Crisis in France: A Chronology

French card market and new digital payment. France has a well-developed bankcard market, including Cartes Bancaires CB, the leading payment system, created by French banks in 1984.[4] In 2020, the latter had more than 100 members (including payment service providers, banks and electronic money institutions) and counted 73 million CB cards (including 64 million contactless cards) and 2 million CB-affiliated merchants (Cartes Bancaires CB, 2020). In order to make bank cards more attractive and easier to use, French banks have decided to launch massive quantities of cards with contactless technology in addition to standard contact technology.[5] Contactless payment allows to pay by bank card (or smartphone) in a dematerialized way without having to enter your four-digit confidential code on the electronic payment terminal. This payment method is recent, the first payment terminal was approved in 2011, and its adoption by the population began to become significant

[3]For literature on payment choice and usage of payment instruments see for example Ching and Hayashi, 2010; Jonker, 2011;Arango et al., 2015; Bounie et al., 2016;Wang and Wolman, 2016, Stavins, 2018.

[4]Cartes Bancaires CB is an economic interest grouping that defines the operating methods for payment by CB card (physical or dematerialized), in the various purchasing environments. CB cards are recognizable by the ”CB” logo that they carry.

[5]The development of contactless card technology in France was one of the main objectives of the French national strategy for cashless payments designed by the Ministry of Finance and Public Accounts, the Ministry of the Economy, Industry and Digital Affairs and the Bank of France. For more details, please see this following document National Strategy on Means of Payment, 2015-2018.

from 2014 to 2016. It uses Near Field Communication (NFC) technology, which allows cards or cell phone and a payment terminal to communicate wirelessly with each other without having to enter a secret code. NFC is, in a nutshell, a technology that allows secure data exchange within a 10 cm radius. For more information on NFC technology, please refer to Egger (2013) who gives an overview of NFC technology and its applications. Initially, the limit of contactless payment was 20 euros until October 2017 where it increased to 30 euros. At the end of 2014, 46 percent of CB cards, i.e. 28 million contactless CB cards, and 20 percent of CB merchants were equipped with the CB contactless technology; overall, 64.5 million contactless CB transactions for a total amount of EUR 706.5 million were recorded by CB. Five years later, at the end of 2019, 82 percent of CB cards and 67 percent of CB merchants were contactless, for a total activity of about 3.4 billion contactless CB transactions and EUR 37.6 billion. In 2020, the world was affected by the COVID-19 pandemic. In order to halt the spread of the virus in France, the government imposed a first containment from mid-March to mid-May. To support this citizen initiative, on May 11, 2020, French banks raised the limit for contactless payment to 50 euros in order to reduce physical contact and the risk of infection, and to promote social distancing and contactless behavior. This measure was marked by an acceleration in the use of contactless payment technology. After the first billion transactions reached in 2017, then the 2 and 3 billion exceeded in 2018 and 2019, 4.6 billion contactless CB transactions were made in 2020. Nearly 60 percent of CB transactions under 50 euros were carried out in contactless stores in 2020 and 78 percent of the merchants were contactless in the end of 2020. More than half of CB payments are now made in stores using contactless cards or cell phones, demonstrating the confidence and adoption of this payment method by CB cardholders and merchants (Cartes Bancaires CB, 2021).

COVID-19 pandemic and containment in France. On March 11, 2020, the World Health Organization announced that the COVID-19 epidemic was classified as a pandemic (WHO, 2020). By mid-April 2020, COVID-19 had infected more than 2 million people in 210 countries and caused more than 150,000 deaths. Countries around the world have put in place increasingly stringent public health measures to deal with the pandemic. These measures range from social distancing to complete lockdown (including closure, mobility restrictions and mandatory confinement), invariably restricting economic activities that have serious repercussions. Many governments have put in place massive fiscal stimulus packages to help combat the negative economic consequences of COVID-19. New support programs have been added as the pandemic has evolved. Unfortunately, these drastic measures led to a sharp decline in production levels in many economies, with consumer spending falling by about one-third (INSEE, 2020b; Bounie et al., 2020b,a). In the COVID-19 era in France, the first cases of COVID-19 were identified at the end of January 2020. As a result, France has put in place a plan to respond to the coronavirus epidemic. On March 12, the French President announced in his first speech on public television that all schools and universities would close, and then ordered the closure of non-essential stores (exceptions for stores such as supermarkets, grocery stores, bakeries, pharmacies, banks, grocery stores, gas stations and tobacconists). This first speech was followed by a second one on March 16, when more than 4,500 cases of infection were confirmed. The French authorities announced a mandatory home lockdown for 15 days starting at noon on March 17. This period was extended twice and ended on May 10.During this period, all travel was reduced to what was deemed strictly necessary, companies were required to organize themselves to facilitate remote work, and meetings with family or friends were prohibited. Besides, the borders of the Schengen area were closed and travel between non-European countries and the European Union was suspended. Meanwhile, the number of deaths due to coronavirus increased dramatically, with more than 10,000 people dying. Between May 11 and June 1, the first phase of a gradual deconfinement and lifting of restrictions took place. During this period, all gatherings, meetings, activities, travel and public transport users were required to respect the rules of social distancing. Public access to parks, gardens and green spaces in urban areas was prohibited in French areas classified as "red zones". Most businesses reopened, but restaurants, cafés and bars remained closed. A travel declaration is no longer required for travel outside of one's place of residence. As of June 2, the second, third and final phase of deconfinition began, with an easing of restrictions. All regions have been classified as "green zones". Cafés, restaurants, pubs, cinemas, vacation centers, sports halls for group sports, all day care centers, schools and colleges (junior high schools) were allowed to reopen. France reopened its borders with non-EU countries. From August to October, cases of infection and death due to coronavirus began to increase again. On September 12, France recorded for the first time more than 10,000 new cases in a single 24-hour period. From October 17, French authorities imposed a curfew in the large city where the virus was circulating heavily. This measure was followed by a second national containment from October 30 to December 15, followed by a national curfew extended to every day between 6 p.m. and 6 a.m.

2.2 Resilience to Shocks: Theoretical Framework and Hypothesis

In this section, I propose a very simple framework to examine the resilience of merchants using the latest digital payment technology to different types of staggered shocks. To do so, I study the effects of these shocks on merchant sales and substitution between payment methods. I compare the sales of merchants who accept the latest payment technologies with those who do not accept them before and after three staggered shocks, including shocks that affect the entire economy (e.g., the COVID-19 pandemic) and shocks that affect only one payment method (e.g., an increase in the digital payment limit).

Suppose there are two types of merchants: those with the latest payment technology (e.g., contactless payment), denoted i, and those without, denoted j. At time t where there is no shock, a merchant i has sales from three payment technologies that are available on the market: a contactless card technology denoted $contactless$, a contact card technology denoted $contact$, and a non-card technology denoted $cash$ (such as cash and cheque). The total sales of merchant i at time t, $S_{i,t}$, is then composed of sales from card payments, $S_{i,t}^{card}$ (= $S_{i,t}^{contactless\ card}$+$S_{i,t}^{contact\ card}$), and sales from cash payments, $S_{i,t}^{cash}$. Similarly, the total sales of merchant j without contactless payment technology, $S_{j,t}$ would be composed of sales from card payments, $S_{j,t}^{card}$ (=$S_{j,t}^{contact}$), and sales from cash payments, $S_{j,t}^{cash}$.[6]

At time $t+1$, suppose now that a first shock happens and affects the whole economy. The total sales of merchants i and j at time $t+1$ is respectively

$$S_{i,t+1} = S_{i,t+1}^{contactless} + S_{i,t+1}^{contact} + S_{i,t+1}^{cash}.$$

$$S_{j,t+1} = S_{i,t+1}^{contact} + S_{j,t+1}^{cash}.$$

At time $t+2$, a second shock occurs and concerns only one payment method, this is the increase of the contactless payment limit. This shock should *a priori* significantly affect merchants using this technology. The sales of the latter would be

$$S_{i,t+2} = S_{i,t+2}^{contactless} + S_{i,t+2}^{contact} + S_{i,t+2}^{cash},$$

while the sales of the other merchants would be

$$S_{j,t+2} = S_{j,t+2}^{contact} + S_{j,t+2}^{cash},$$

At time $t+3$ a last and third shock occurs and hits for the second time the whole world. Here is the sales of merchant i

$$S_{i,t+3} = S_{i,t+3}^{contactless} + S_{i,t+3}^{contact} + S_{i,t+3}^{cash},$$

and the sales of merchant j is

$$S_{j,t+3} = S_{j,t+3}^{contact} + S_{j,t+3}^{cash}.$$

[6]Indexes i and j allow the sales to depend on several merchant characteristics, such as its sector of activity and its location.

Following the equations above, it is important to note that the different shocks may affect merchant's total sales for many reasons. For instance, a shock such as COVID-19 pandemic where the social distancing is the rule may permit to merchants who have a specific means of payment (e.g., contactless card technology) to attract new customers and new sales.[7] In addition, the closure of non-essential areas such as restaurants during the pandemic could also allow merchants to sell more to loyal customers or simply replace non-card payments with card payments. Conversely, merchants with only contact technology may lose consumers who may be afraid to use this type of technology where they are forced to enter their PIN code on the payment terminal and could therefore contract the coronavirus.

Let $\Delta_{i,j}S_{t+n}$ denote the change between the total sales of the merchant i with contactless payment and the merchant j without resulting from the shock at time $t+n$ and defined as follows:

$$\Delta_{i,j}S_{t+n} = \underbrace{S^{contactless}_{i,t+n} + S^{contact}_{i,t+n} - S^{contact}_{j,t+n}}_{\Delta_{i,j}S^{card}_{t+n}} + \underbrace{S^{cash}_{i,t+n} - S^{cash}_{j,t+n}}_{\Delta_{i,j}S^{cash}_{t+n}} \tag{1}$$

$\Delta_{i,j}S^{card}_{t+n}$ ($\Delta_{i,j}S^{cash}_{t+n}$) represents the change between the total card sales (cash sales) of the merchant i with contactless payment and the merchant j without resulting from the shock at time $t+n$.

Equation (1) can be used to analyze the resilience to a shock and estimate the substitution between payment methods. First, in the absence of shocks (at time t) or in the presence of shocks that have an impact on the economy as a whole (at time t+1 or t+3), I do not expect any significant difference between the sales of merchants with the latest digital payment and those without, with similar characteristics (i.e., $\Delta_{i,j}S_{t+n} = 0$). However, based for instance on the change in card sales, if $\Delta_{i,j}S^{card}_{t+1} > 0$ and $\Delta_{i,j}S^{card}_{t} = 0$, then merchants with contactless technology are more resilient to a shock that affects everything and everyone. The shock increases the card sales for the merchant with contactless technology by attracting new customers, encouraging consumers to use card technologies more intensively and by displacing cash payments. The change observed after a given shock might not be attributed to that shock. Note that if $\Delta_{i,j}S^{card}_{t+1} - \Delta_{i,j}S^{NewClient\ card}_{t+1} > 0$ then there is a sharp substitution between card and non-card payment technologies (where $\Delta_{i,j}S^{NewClient\ card}_{t+1}$ corresponds to the new card sales carried out exclusively by new clients at time t+1). The NFC-equipped merchant may increase its sales at $t+1$ by replacing more cash payments with card payments compared to the merchant who does not use this technology.

[7] Note that merchants who offer contactless payments may gain two types of customers: 1) customers who would have made a purchase anyway, but prefer not to go to a merchant who does not offer these contactless payments, and so go to the merchant who does; these transactions are a zero sum game, so one merchant's gain is another merchant's loss; 2) customers who would not have bought the product at all in the absence of a merchant offering contactless payments, so that these purchases are 'saved' for the economy as a whole.

Second, in the case where a shock affects one means of payment, I expect no significant difference between merchants with similar characteristics (i.e., $\Delta_{i,j} S_{t+2} = 0$) but a strong substitution between payment methods for the merchants with this method (i.e., $\Delta_{i,j} S^{card}_{t+2} = -\Delta_{i,j} S^{cash}_{t+2} > 0$). The increase in the contactless payment limit should therefore replace the sales from the other payment methods towards this payment method. However, if $\Delta_{i,j} S^{card}_{t+2}$ >0 and $\Delta_{i,j} S^{card}_{t+1}$ >0, in addition to the first shock that shows the resilience of merchants with contactless technology to the global shock, the increase of the contactless payment limit allows these merchants to make more new sales and significantly increases substitution between card and cash sales. To estimate the impact that can be exclusively attributed to the second shock, we have to substrate the impact of the previous shock due to the fact that the latter may also influence the next one. Hence, if $(\Delta_{i,j} S^{card}_{t+2} - \Delta S^{NewClient\ card}_{t+2})$ - $(\Delta_{i,j} S^{card}_{t+1} - \Delta_{i,j} S^{NewClient\ card}_{t+1}) > 0$ there is a sharp substitution between card and cash technologies that can be exclusively attributed the the second shock. The increase of the contactless payment limit may substitute contact payment to contactless payment. Moreover, it is possible to estimate the substitution between card payment methods. If for instance $S^{contact}_{i,t+2} - S^{contact}_{j,t+2} < 0$ and $S^{card}_{i,t+2} - S^{card}_{j,t+2} > 0$, then a negative externality occurs, and the merchants gain lower sales from contact card payments while still gaining from the shock via a cannibalization between contact and contactless payments. Finally, note that if $\Delta_{i,j} S^{card}_{t+3} - \Delta_{i,j} S^{card}_{t+2} > 0$, after removing the effects of previous shocks that affect the whole market and one of means of payment, the second shock as a whole increases the sales of merchants contactless payment relative to those without. This highlights the ability of merchants with the latest technology to mitigate the effect of a second shock that impacts the whole economy.

Using card-sales transactions data, score matching and difference-in-differences methods, I propose in the next section to study the resilience of merchant with contactless payment to three shocks that happened in 2020 in France and then to estimate the substitution between payment methods. I intend to compare merchants who do contactless transactions to those who do only contact payment, with similar observable characteristics.

2.3 Raw Data and Sample Design

Thanks to a partnership with Cartes Bancaires CB, I have access to a unique data set on card-sales transactions for all merchants in France from 2019:01 to 2020:12. Created 1984 by the French banks, Cartes Bancaires CB is one of the leading schemes in France with 73 million CB cards and 2 million CB-affiliated merchants. It collects the CB card transactions for all CB merchants including their merchant business identification number (SIRET code). Using detailed card transactions[8] I calculate the number of cards and number of new cards for each merchant that I consider to be cards that have never made a transaction before 2019. Additionally, using merchant business identification number (SIRET code) and public data from the National Institute of Statistics (SIRENE) on French establishments, I obtain further information on each merchant: date of creation, sector activity (NAF code), number of employees, and geographical location (postal code or longitude and latitude).[9]

The data set offers several key benefits for my study. First of all, one of the main advantages of my data is that I have card and mobile transactions information from all the banks in France, which allows me to fully capture all mobile and card sales for each merchant and then be able to generalize my findings. Second, digital payment is transforming the global payment system, household consumption behavior, and merchant selling behavior. Merchant card transactions give me the ability to directly verify the impact of a payment technology shock (such as an increase in the contactless payment limit) as well as a global shock (such as a lockdown due to the COVID-19 epidemic) on the ability of merchants to mitigate them. Third, the high-frequency card-sales transactions data recorded with little measurement error, compared to the traditional survey-based data set can allow me to track the sales to each merchant through the transaction record, which is crucial for my study. Relative to very few studies utilizing merchant transaction sales, I am able to study a long time series (two-year period) of sales from a large scale of merchants in different categories.

In 2020, the world was affected by the COVID-19 pandemic. To stop the spread of the virus in France, the government imposed a first containment from mid-March to mid-May. In addition, in mid-May 2020, the French banks increased the limit for contactless payment in order to reduce physical contact and promote social distancing. Again, after a significant increase in the contamination of individuals by coronavirus in October 2020, the French government decided to impose a second containment. I use these three staggered shocks to study the resilience of merchants using contactless payment technology and their effects on merchant sales and substitutions between means of payment. For comparability purposes, I focus the analysis on offline merchants who accept contactless payments since 2019:01 (the treatment group) and those who still do not accept

[8]These datas set are a representative sample of CB transactions and were made available by CB. I exploit the card payments data in accordance with the EU General Data Protection Regulation, in application of Article 89. I use the abbreviation 'CB' to indicate the source of the card payments.

[9]The SIRENE database is available on the following link: https://www.data.gouv.fr/en/datasets/base-sirene-des-entreprises-et-de-leurs-etablissements-siren-siret/

contactless payments up to 2020:12 (the control group).[10] To ensure that the merchants in my sample are actively in business and have not been directly affected by the measures, I require them to have positive card sales for 24 months (all months from 2019:01 to 2020:12) and to be an essential sector including supermarkets, groceries, bakeries, pharmacies, health, tobacco stores, and fuel. Finally, I exclude all online stores from my sample because the increase of contactless payment limit should only affect offline sales. After this step, I am left with 94,199 unique merchants in total during the two-year period. My data set covers 75,668 merchants in the treatment group and 18,531 merchants in the control group.

Although the COVID-19 crisis is exogenous to merchants and allows me to compare both groups using the difference-in-differences approach, merchants who accept contactless payments may not be directly comparable to those who do not. Indeed, merchants may decide when to accept the contactless payment technology, thereby making the acceptance of contactless payments a non-random experiment. To avoid possible bias, I use a score matching approach to compare merchants with similar pre-treatment characteristics. These include merchant characteristics and its city characteristics. A merchant may indeed for instance be more willing to accept contactless payments as it is a supermarket and the contactless payments is high in its city. Therefore, in addition to score matching, I use difference-in-differences setting and rely on the untreated merchants to investigate the resilience to shock as well as the effect of the staggered shocks on the substitutions between payment methods. This approach requires the control group to have the same sales patterns as the treatment group in the pre-treatment period so their sales after the shocks constitute a valid counterfactual.

Table 1 provides summary statistics on merchant and its city characteristics for the treatment and control groups in my sample. It highlights that the control group (non-NFC equipped merchants) is not directly comparable with the treatment group (NFC equipped merchants) along several dimensions (Column (5)). The control group on average has, for instance, a older than the treatment group and is much more likely to live in big city. This suggests that the treatment group may have a sales pattern inherently different from that of the control group. For my purposes and to reliably identify the effect, I construct a matched sample of merchants (with and without contactless) that are observationally similar. Specifically, I compute propensity scores based on a logistic regression[11] using a rich set of merchant characteristics including its age, sector activity, average transaction value, card-sales growth, a dummy variable indicating whether the firm has employees, the num-

[10] Additionally, I only include the card sales within France metropolitan and drop all in overseas territories.

[11] For further information on propensity score method, please refer for example to Bounie and Camara (2020).

ber of employees,[12] number of bank account as well as merchant and city characteristics including the population, the share of contactless payments, and the share of merchants with a contactless payment technology. I perform the nearest-neighbor matching based on the computed propensity scores. Overall, only 8,688 merchants in the treatment group are paired and Figure 1 confirms the existence of a region of common support.

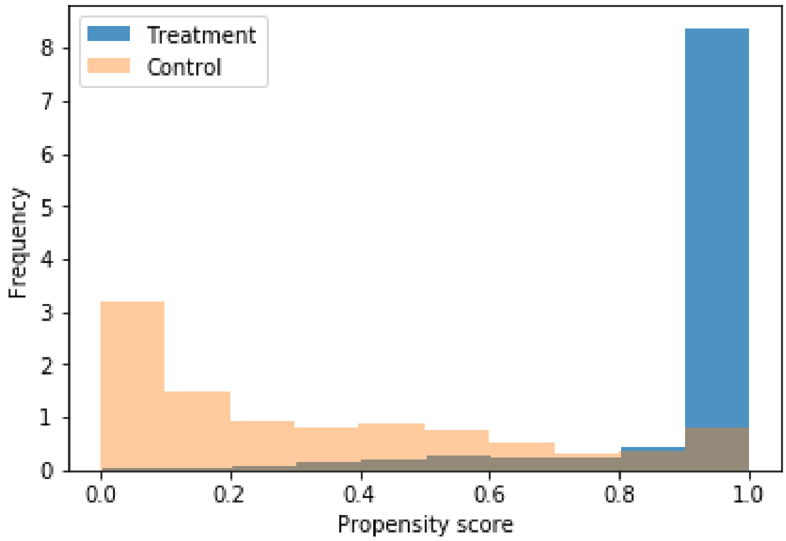

Figure 1: Region of Common Support

After matching, the differences between the treatment and control groups in age, average transaction value, transaction volume, population, share become statistically and economically indistinguishable from zero (Column (10) of Table 1). Differences in other characteristics also shrink significantly. In addition to the mean statistics, the distribution of the propensity scores of the treatment and control groups after matching are also similar and comparable. Hence, I have a panel of reasonably balanced treatment and control individuals, which allows us to identify the average response as well as the dynamics of the treatment effect. This analysis allows me to use a difference-in-differences setting to identify the card-sales response to an epidemic shock for merchants who accept contactless payments.[13]

[12] A categorical variable of 16 classes representing the number of employees (from 1 employee to more than 10,000 employees).

[13] As it is standard in the literature (see for example Agarwal et al. (2015) and Bounie and Camara (2020)), I can use a difference-in-differences setting on the overall matched sample, but also on sub-samples of merchants (e.g., small merchants). In the following sub-sample analyses, I also checked the quality of both groups by redoing the score matching and testing that the common support assumption is not violated.

Table 1: Summary statistics of the treatment and control groups before and after score matching

	Treatment group		Control group			Matched treatment group		Matched control group		
	Mean	SD	Mean	SD	Diff.	Mean	SD	Mean	SD	Diff.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Merchant characteristics										
Age	10.64	9.02	13.64	9.87	3.006***	12.88	9.78	12.84	9.83	-0.038
Number of bank accounts	1.06	0.32	1.05	0.35	-0.011***	1.1	0.42	1.09	0.49	-0.003
Log transaction volumes	6.77	1.25	5.21	1.23	-1.563***	5.71	1.23	5.73	1.43	0.019
Average value of transactions	22	12.7	61.43	59.68	39.432***	32.46	23.05	32.09	18.21	-0.366
Growth rate	0.14	0.19	0.11	0.21	-0.025***	0.1	0.19	0.09	0.2	-0.003
Sectors										
Bakery	0.23	0.18	0.02	0.02	-0.21***	0.06	0.05	0.05	0.04	-0.009***
Food	0.21	0.17	0.04	0.04	-0.173***	0.08	0.07	0.08	0.07	-0.0
Fuel	0.02	0.02	0.06	0.05	0.035***	0.09	0.08	0.1	0.09	0.014***
Grocery	0.12	0.1	0.03	0.02	-0.091***	0.06	0.05	0.05	0.05	-0.0
Health	0.11	0.09	0.82	0.15	0.716***	0.64	0.23	0.65	0.23	0.008
Pharmacy	0.2	0.16	0.02	0.01	-0.186***	0.03	0.03	0.03	0.03	-0.0
Supermarket	0.06	0.06	0.01	0.01	-0.05***	0.03	0.02	0.02	0.02	-0.0***
Tobacco store	0.05	0.05	0.01	0.01	-0.04***	0.02	0.02	0.02	0.02	-0.0
Hire	0.82	0.15	0.4	0.24	-0.416***	0.42	0.24	0.4	0.24	-0.018***
Number of employees										
1 to 5 employees	0.5	0.25	0.28	0.2	-0.22***	0.27	0.2	0.27	0.19	-0.004
10 to 19 employees	0.15	0.13	0.02	0.02	-0.133***	0.03	0.03	0.03	0.03	-0.005
7 to 9 employees	0.08	0.07	0.02	0.02	-0.065***	0.03	0.03	0.02	0.02	-0.003*
20 to 49 employees	0.02	0.02	0.01	0.01	-0.016***	0.01	0.01	0.01	0.01	-0.001
50 to 99 employees	0	0	0	0	0.001***	0	0	0	0	-0.0**
More than 100 employees	0	0	0	0	0.002***	0	0	0	0	0.0***
Merchant city characteristics										
Log of population	9.84	1.19	10.23	1.17	0.394***	9.96	1.17	9.94	1.16	-0.022
Share of contactless payments	0.1	0.04	0.09	0.03	-0.003***	0.09	0.03	0.09	0.03	0
Share of NFC equipped merchants	0.59	0.08	0.55	0.08	-0.031***	0.57	0.08	0.57	0.07	0
Observations	75,668		18,531			8,688		8,688		

Notes: This table reports on the summary statistics of the treatment and control groups, both before and after score matching. The treatment sample consists of merchants who accept contactless payments since 2019:01, and the control sample represents all other merchants who still do not accept contactless payments up to 2020:12. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

Of course, the matched sample method may not eliminate unobservable differences between NFC-equipped and non-NFC-equipped merchants, which could affect their sales patterns. In my analysis, I intend to explicitly test for any differences between the treatment and control groups in sales patterns in the pre-treatment period. In addition, I perform various robustness checks to validate my matched sample approach. Furthermore, I will test the external validity of my conclusions by running regressions of the differences in the differences in the full (unmatched) sample. I first plot, in Figure 2, the unconditional mean of the total card-sales amount and count of both the treatment and control groups in the matched sample over the period 2019:01-2020:12.

Strictly speaking, on average, the treatment group has a lower total sales than the control group. Moreover, the difference in total sales between the treatment group and the control group before the first shock called the "first containment" remains constant, which confirms the underlying identifying assumption of a parallel trend. Note that the gap between the treatment group and the control group visibly increases after the second shock called the "increase in the contactless payment limit", which provides the first suggestive evidence that merchants with contactless payment are more resilient to the shock and maybe attract new sales as well as replace the cash payment with card payment compared to the merchants who still do not accept contactless payment.

(a) log (total sales amount) (b) log (total sales count)

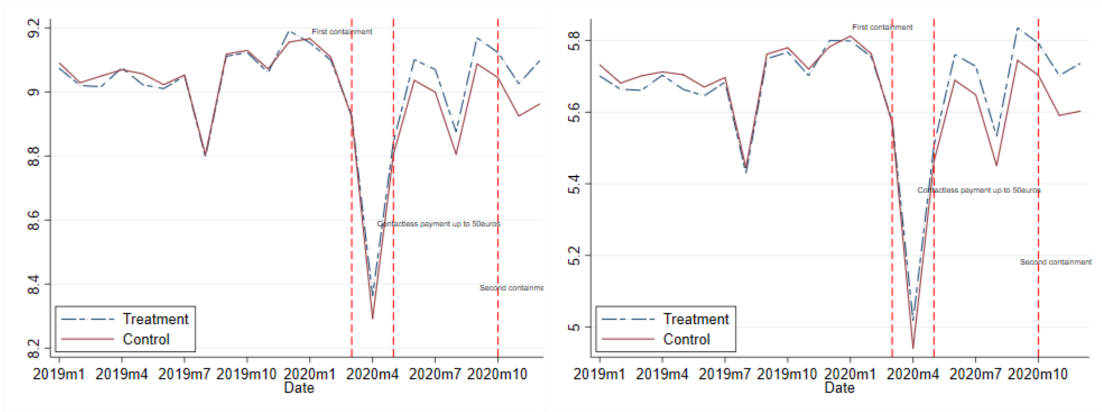

Figure 2: Test of Common Trend Assumption

2.4 Methodology

In this paper, I analyze the resilience of merchants with the latest digital payment to different shocks that occurred in 2020 in France using a difference-in-differences setting. In doing so, I compare the matched merchants with contactless payment since 2019:01 (treatment group) to the matched merchants without contactless payment up to 2020:12, during the first containment in France (from 2020:03 to 2020:05), after the increase of contactless payment limit up to 50 euros in mi-May 2020 (from 2020:06 to 2020:09), and during the second containment in France (from 2020:10 to 2020:12). The pre-treatment period is from 2019:01 2020:02, and the post-treatment period is from 2020:03 to 2020:12.

First, I study the changes in average monthly sales between merchants with and without contactless payment after the first containment using the following specification.[14]

$$Log(Y_{i,t}) = \beta_{pre} \cdot Treat \times Pre + \beta_{post} \cdot Treat \times Post + \gamma_i + \gamma_t + \varepsilon_{i,t} \qquad (2)$$

Second, I use the following specification to distinguish the average monthly impacts of different

[14] My approach is similar to those of Agarwal et al. (2007), Aaronson et al. (2012), Agarwal and Qian (2014), Agarwal et al. (2019), and Bounie et al. (2020b).

shocks:

$$Log(Y_{i,t}) = \beta_{pre} \cdot Treat \times Pre + \beta_{cont1} \cdot Treat \times Cont1 + \beta_{after1} \cdot Treat \times After1 + \beta_{cont2} \cdot Treat \times Cont2 + \gamma_i + \gamma_t + \varepsilon_{i,t} \quad (3)$$

The dependent variable $Log(Y_{i,t})$ is either the logarithm of total card-sales amount, or the logarithm of total card-sales count carried out by merchant i during the month t. $Treat$ is a dummy variable for the treatment group. Pre is a binary variable that equals one for the two months of 2020 before the first containment (i.e., from 2020:01 to 2020:02), and $Post$ is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). $Containment1$ is a binary variable that equals one for the months of the first containment (i.e., from 2020:03 to 2020:05), $AfterContainment1$ is a binary variable that equals one for the months after the first containment and the increase in the contactless payment limit (i.e., from 2020:06 to 2020:09), and $Containment2$ is a binary variable that equals one for the months the second containment (i.e., from 2020:10 to 2020:12). γ_i captures the individual fixed effects to absorb time-invariant factors at the merchant level, and γ_t controls for the time-varying trend of monthly sales. Note that standard errors in all regression analyses are clustered at the individual level.

The parameter β_{post} in equation (2) captures the change in average monthly sales between merchants with and without contactless technology during and after the first containment. The parameters β_{Cont1}, β_{After1}, and β_{Cont2} in equation (3) capture the variation in average monthly sales between merchants with and without contactless technology during the first containment, after the first containment and the increase of contactless payment limit, and during the second containment, respectively. β_{pre} measures the difference in the sales trend between the treatment group and the control group during the two pre-treatment months (compared to the benchmark period). This is a way to perform a placebo test directly in the main specification. By the way, validity of my difference-in-differences regression design requires β_{pre} to be statistically and economically indistinguishable from zero.

In addition to the first two specifications, I want to study the dynamics of the difference in monthly sales. I therefore consider the following distributed lag model:

$$Log(Y_{i,t}) = \sum_{Month \geq 2020:01} \beta_{month} \cdot Treat \times Month + \gamma_i + \gamma_t + \varepsilon_{i,t}. \quad (4)$$

The coefficient $\beta_{2020:03}$ measures the immediate change in sales of the first month of the first containment, and coefficients $\beta_{2020:04}$, ..., $\beta_{2020:12}$ measure the additional marginal difference after the shock, respectively. Similarly, coefficients $\beta_{2020:01}$ and $\beta_{2020:02}$ capture the differences in sales between the treatment and controls group in the pre-treatment days. The results can be interpreted as an event study (see Agarwal et al. 2007, 2019; Bounie et al. 2020b).

Finally, I study the heterogeneity in the response to the shocks across different groups of individuals (e.g., small versus larger merchants) using the following specification:

$$Log(Y_{i,t}) = \beta_{pre} \cdot Treat \times Pre + \beta_{post} \cdot Treat \times Post + \beta_{post\times G} \cdot Treat \times Post \times G + \gamma_i + \gamma_t + \varepsilon_{i,t}. \quad (5)$$

The new coefficient $\beta_{post\times G}$ captures the extra sales difference for the group defined by G, relative to the benchmark group.

3 Main Results

I begin by estimating the average response of card-sales change to the COVID-19 shock and the increase in the limit of contactless payment. To sharpen the results, I split the effect through the three staggered shocks including the first containment, the increase of contactless payment limit, and the second containment in response to the COVID-19 epidemic in France. In the main analysis, I focus on the matched sample in the period from fourteen months before to ten months after the first containment in France (2019:01–2020:12). I further study the heterogeneous response across different types of merchants including small and new merchants. Finally, I examine the substitution between payment methods resulting from the shocks, in particular after the increase in the contactless payment limit.

3.1 Card-Sales Response and Merchant Resiliency

I first examine the card-sales response to the COVID-19 crisis. I observe a significant increase in the sales of merchants with contactless payment technology relative to those without this technology. Table 2 shows results on the average response by applying equations (2) and (3) to total card sales change. Columns (1) shows that the merchants with contactless payment experience on average an increase of 8.3 percent.[15] The equivalent is 10.2 percent for card-sales count increase (column (3) of Table 2). The effects are both statistically and economically significant.

In columns (2) and (4), I separately estimate the effect that can be attributed to each shock. I find that during the first containment the total card-sales amount (count) of merchants with contactless payment technology increase on average by only 4.7 percent (6.3 percent) compared to the

[15] The estimated coefficient for log of total sales amount in column (1) of Table 2 is 0.08, which is equivalent to a percentage increase of 8.3 percent (= exp(0.08) – 1) in the amount of monthly card sales more than their counterparties during the 10 month period upon the first containment shock, compared to the first twelve months prior to the shock. All subsequent percentage effect interpretations for log dependent variables follow the same formula.

merchants who still do not accept contactless payment. After the first containment – during the de-containment period which also corresponds to the increase in the contactless payment limit – I observe a significant increase in the card-sales amount (count) about 8.3 percent (10.4 percent) for merchants with contactless payment technology compared to those without. Even during the second containment, I find evidence that the acceptance of contactless payment in the time of COVID-19 increase the sales of merchants with the latest digital payment relative to their counterparties. These results suggest that the increase of contactless payment limit may promote an attraction of new sales or displacing sales from the other means of payments.

In all four columns in Table 2, coefficient estimates on the pretreatment period variable ($Treat \times Pre$) are both economically very small and statistically insignificant at 10 percent level. For example, the treatment group's monthly total card-sales amount is on average -0.003 less than the control group in the two months before the first containment and is statistically insignificant (p-value = 0.31). Note that this approach is another way to check the robustness of my results through a placebo test directly in my difference-in-differences regression. To interpret, these results suggest that before the shock, there are no differences in card-sales patterns between the matched merchants with and without the latest technology of payment. On the other hand, the close-to-zero pre-trend estimations further confirm that the differences in card sale changes are attributable to the shocks. F-tests suggest that the estimated coefficients for $Treat \times Pre$ and $Treat \times Post$ are statistically different at the 1 percent level, for both sales amount and count of transactions. This provides strong evidence in support of my research design: the matched sample of merchants with contactless payment technology (treatment) and merchants without contactless technology (control) is balanced and homogeneous (in their sales trend), and the differences in sales after the first containment indeed measure the treatment group's response to the pandemic shock. These results suggest that merchants with contactless payment are more resilient to shocks. They emphasize that the acceptance of contactless payment during COVID-19 pandemic permit to mitigate the impact of shocks while attracting new consumers, substituting card sales to non-card sales, or both.[16]

[16]New merchant sales to with contactless payment can also be explained by the fact that because there are many non-essential sectors that are closed and consumers need to eat, they are forced to make purchases from merchants in essential sectors such as supermarkets.

Table 2: Average Monthly Sales Response to the COVID-19 Crisis

	Log(Total Sales Amount)		Log(Total Sales Count)	
	(1)	(2)	(3)	(4)
Treat x Pre	-0.003	-0.003	0.007**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)
Treat x Post	0.080***		0.097***	
	(0.005)		(0.005)	
Treat x Containment1		0.046***		0.061***
		(0.008)		(0.008)
Treat x After Containment1		0.080***		0.099***
		(0.005)		(0.005)
Treat x Containment2		0.113***		0.130***
		(0.006)		(0.006)
Constant	8.988***	8.988***	5.631***	5.631***
	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Effects	Merchant, year-month			
Observations	417,024	417,024	417,024	417,024
R-squared	0.944	0.944	0.938	0.938

Notes: This table reports the change in average monthly sales between the matched merchants with and without contactless payment technology to the COVID-19 crisis due to COVID-19 pandemic (equations (2) and (3)) in the period from 2019:01 to 2020:12. The dependent variable is the logarithm of total monthly sales amount in columns (1)-(2) or the logarithm of total monthly sales count in columns (3)-(4). $Treat$ is a dummy variable for the merchants with contactless payment technology (treatment group). *Pre* is a binary variable that equals one for the two months of 2020 before the first containment (i.e., from 2020:01 to 2020:02), and *Post* is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). $Containment1$ is a binary variable that equals one for the months of the first containment (i.e., from 2020:03 to 2020:05), $AfterContainment1$ is a binary variable that equals one for the months after the first containment and the increase in the contactless payment limit (i.e., from 2020:06 to 2020:09), and $Containment2$ is a binary variable that equals one for the months the second containment (i.e., from 2020:10 to 2020:12). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

In an attempt to better understand the exact timing at which the effect takes place, I estimate equation (4) of the monthly dynamic evolution of card-sales response before and during the COVID-19 crisis. Figure 3 shows that the increase in card sales by NFC-enabled merchants relative to non-NFC-enabled merchants primarily takes effect in the first month following the first containment in March, and the effect continues throughout the months following the de-containment and the increase in the contactless payment limit until the second containment. Take the sales amount as an example, compared to the months in 2019, the monthly NFC-equipped merchant card-sales amount is estimated to be 5 percent higher per month than that from non NFC-equipped merchants in the first shock months (p-value<0.00), 8 percent higher in the second shock months (after the increase in contactless limit), and 12 percent higher in the third shock related to the second containment (p value<0.00). The effect of the increase in the contactless payment cap on card sales occurs immediately and continues in the following months. The impact intensifies with the second containment, especially in December, which is an unusually festive month (approximately 15 percent relative increase in sales for merchants using contactless payment technology). The results are similar to the card-sales count dynamic response. These findings suggest that the increase in the contactless payment limit has played a key role in merchant resiliency, including attracting new customers and substitution between payment methods.

(a) log (total sales amount)　　(b) log (total sales count)

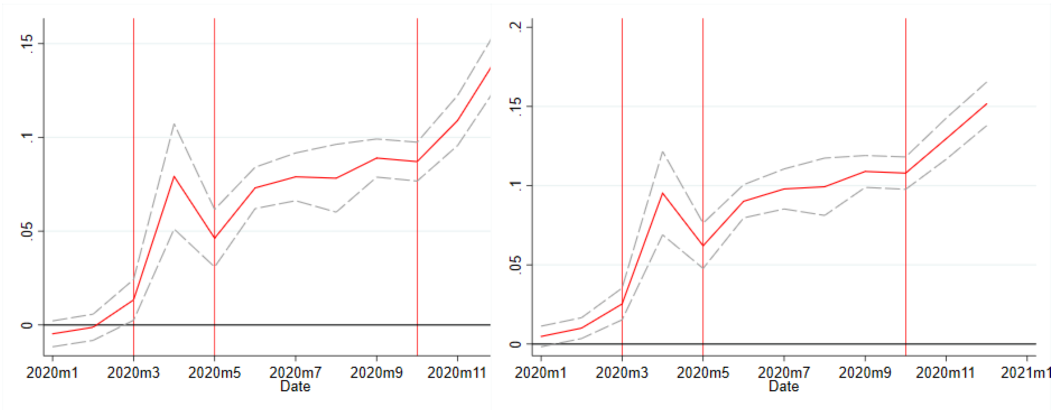

Figure 3: Dynamic response to the COVID-19 Crisis

Notes: This figure plots the coefficients β_{month} estimated from equation (4), representing the estimated monthly sales response dynamics, with $month$ = 2020:01, 2020:02, 2020:03,..., 2020:11, 2020:12, along with their corresponding 95 percent confidence intervals. The x-axis denotes the month and the y-axis shows the coefficient, representing percentage estimated sales response for the given month. March 2020 was the first month of containment, May 2020 the month of de-containment and the increase in contactless payment limit, and October 2020 the month of the second containment in response to COVID-19 pandemic in France.

3.2 Heterogeneity in Card-Sales Response

Here I study the heterogeneous impact of the COVID-19 pandemic on the sales of small merchants and new entrepreneurs using the latest digital payment technologies. Indeed, the resilience of merchants to shocks can vary significantly according to their size and age.

Small merchants who usually carryout out small value per transactions may accept more often contactless payment technology. Therefore, I check whether the small merchants – defined as those merchants with median monthly sales in 2019 lower than 50th-percentile within each merchant sector – experience larger increase in the sales amount and count. As expected, columns (1) and

(4) of Table 3 shows that the sales amount (count) increases 8 percent (11 percent) more for the small merchants with contactless technology compared to their larger counterparties with the same technology (pvalue$<$0.001).

Contactless payment technology facilitates small transactions and could increase the tendency for consumers to pay more without cash for small purchases. In addition, I investigate whether the sales of merchants making small transactions are benefiting from the increase in the contactless payment limit. In doing so, I further divide the small merchants into two sub-groups according to their median transaction size per purchase in 2019. Specifically, I define the small merchants with median transaction size in 2019 below the 50th-percentile as the small transaction size type and expect them to exhibit the strongest increase in card sales. Results are consistent with my expectation. Columns (2) and (5) of Table 3 show evidence that the positive effect on card sales for small merchants is driven by the ones featuring small-size transactions. The change in log sales amount after the three staggered shocks for small merchants with small transaction size is positive and about 20 percent higher than the small merchants without small transaction size. The difference is statistically significant at the 1 percent level. The result is 24 percent for the card transaction counts.

The benefits from cheaper and more convenient payment technology are likely to be greater for new entrepreneurs. They tend to operate on a smaller scale, with a higher marginal benefit due to lower transaction costs and improved transaction efficiency. In addition, new merchants have a less stable customer base, resulting in a greater impact from increased consumer traffic. I find consistent evidence from the COVID-19 era and after the increase in the limit of the latest digital payment. I consider a merchant to be new if he was 0 or 1 year old in 2019. Others are considered old merchants. As shown in column (3) of Table 3, while older merchants with contactless payment technology saw an increase in card sales of about 8 percent over merchants without the latest technology after the shocks, when compared to younger entrepreneurs, the younger ones increased their card sales by 3 percent more.

Table 3: Response of Small Merchants and New Entrepreneurs

	Log(Total Sales Amount)			Log(Total Sales Count)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat x Pre	-0.003	-0.003	-0.003	0.007**	0.007**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Treat x Post	0.029***	0.029***	0.078***	0.030***	0.030***	0.096***
	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)
Treat x Post x SmallMerchant	0.081***	0.049***		0.106***	0.066***	
	(0.007)	(0.007)		(0.006)	(0.006)	
Treat x Post x SmallMerchant x SmallTran.Size		0.195***			0.239***	
		(0.014)			(0.014)	
Treat x Post x YoungMerchant			0.030**			0.023
			(0.015)			(0.016)
Constant	8.988***	8.988***	8.988***	5.631***	5.631***	5.631***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Effects	Merchant, year-month					
Observations	417,024	417,024	417,024	417,024	417,024	417,024
R-squared	0.944	0.944	0.944	0.938	0.938	0.938

Notes: This table reports the change in average monthly sales between the matched merchants with and without contactless payment technology to the COVID-19 crisis (equation (5)) in the period from 2019:01 to 2020:12 of small and new merchants. The dependent variable is the logarithm of total monthly sales amount in columns (1)-(3), the logarithm of total monthly sales count in columns (4)-(5) or the logarithm of the number of new customers in columns (5)-(6). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). *SmallMerchant* is a binary variable equal to one for the small merchants, which is defined as merchants with median monthly sales lower than the 50th-percentile within each sector in 2019. *SmallTrans.Size* is is a dummy variable equal to one for the merchants with median transaction size per purchase lower than 50th-percentile among the small merchants in 2019. *YoungMerchant* is is a dummy variable equal to one for merchants aged 0 or 1 year old in 2019. *Pre* is a binary variable that equals one for the two months of 2020 before the first containment (i.e., from 2020:01 to 2020:02), and *Post* is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). $Containment1$ is a binary variable that equals one for the months of the first containment (i.e., from 2020:03 to 2020:05), $AfterContainment1$ is a binary variable that equals one for the months after the first containment and the increase in the contactless payment limit (i.e., from 2020:06 to 2020:09), and $Containment2$ is a binary variable that equals one for the months the second containment (i.e., from 2020:10 to 2020:12). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

3.3 Card-Sales Response by Business Sector

This section examines the degree of merchant resiliency by business sector. As validated above, the increase in card sales may be mainly due to sectors where merchants are smaller (and have smaller transaction sizes) and newer. The latter, in an effort to improve the in-store shopping experience, reduce queues and save time at the checkout, may be more concerned with the acceptance of contactless payment technologies. To capture heterogeneity between sectors, I classify merchants into eight essential sectors: Supermarket, Food store, Grocery, Bakery, Fuel, Pharmacy, Health, Tobacco store.[17]

Following the methodology described above, in order to capture the real effect for each sector, I apply score matching for each case and verified that the assumptions for identifying the matching (common support assumption) were satisfied.[18] On matched merchants, I perform the same difference-in-differences regression estimation as before. Table 4 shows the estimation results. Not surprisingly, the resilience of merchants who accept contactless payments is most important for bakeries, which are typically small stores and sell low-value items. The average effect increases by 28.7 percent[19] for bakeries that accept contactless payments compared with bakeries that do not. This area is indeed where consumers used to pay cash before, especially for small-size payments. The effect is greater during the second containment, probably due to the Christmas season when people are used to buying cakes. The estimation results also confirm a significant benefit for supermarkets and food stores offering contactless payments compared to the control group, respectively about 19.2 percent and 14.6 percent increase in the amount of card sales. Gas stations with contactless payment technology have the same card sales before and during the COVID-19 crisis as the gas station without contactless payment technology. However, pharmacies and health services such as dentists or general practitioners with contactless technology are more resilient than their counterparties.

[17] I use the "Nomenclature des Activités Françaises" of the National Institute of Statistics (INSEE) to classify business sector. I particularly use the following NAF codes: Supermarket (4711D and 4711F), Food (4721X, 4722X, 4723X, 4725X, 4729X, 4781X, 4631X, 4632X, and 4638X), Grocery (4711B and 4711C), Pharmacy (4773X), Health (861XX and 862XX), Bakery (1071X and 4724X), Tobacco store (4726X and 4635X), Fuel (4730X).

[18] Due to space limitations, the results of the tests are not reproduced in the paper. They are available upon request.

[19] The estimated coefficient for log of card-sales amount on Table 4 is 0.252, which is equivalent to a percentage increase of 28.7 percent (= exp(0.252) – 1).

Table 4: Average Monthly Sales Response by Business Sector

	Log(Total Sales Amount)							
	Supermarket	Grocery	Food store	Bakery	Tobacco store	Fuel	Pharmacy	Health
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A								
Treat x Pre	-0.014	-0.035**	-0.000	-0.018	-0.004	-0.024	0.011	-0.003
	(0.011)	(0.014)	(0.014)	(0.017)	(0.022)	(0.016)	(0.014)	(0.003)
Treat x Post	0.176***	0.064***	0.136***	0.252***	0.086***	0.019	0.130***	0.056***
	(0.021)	(0.020)	(0.020)	(0.024)	(0.029)	(0.025)	(0.018)	(0.005)
Constant	12.199***	8.975***	9.312***	8.364***	10.584***	11.359***	8.823***	8.353***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.001)
Panel B								
Treat x Pre	-0.014	-0.035**	-0.000	-0.018	-0.004	-0.024	0.011	-0.003
	(0.011)	(0.014)	(0.014)	(0.017)	(0.022)	(0.016)	(0.014)	(0.003)
Treat x Containment1	0.165***	0.002	0.095**	0.221***	0.107*	0.002	0.060***	0.017**
	(0.034)	(0.034)	(0.038)	(0.038)	(0.055)	(0.035)	(0.023)	(0.008)
Treat x After Containment1	0.166***	0.077***	0.127***	0.232***	0.055**	0.036	0.151***	0.066***
	(0.020)	(0.019)	(0.018)	(0.026)	(0.027)	(0.026)	(0.020)	(0.006)
Treat x Containment2	0.220***	0.128***	0.221***	0.347***	0.132***	0.000	0.184***	0.089***
	(0.025)	(0.028)	(0.028)	(0.032)	(0.036)	(0.032)	(0.023)	(0.007)
Constant	12.199***	8.975***	9.312***	8.364***	10.584***	11.359***	8.823***	8.353***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.001)
Fixed Effects	Merchant, year-month							
Observations	8,304	22,368	31,872	18,864	6,720	13,152	12,336	254,544
R-squared	0.973	0.899	0.841	0.848	0.868	0.963	0.931	0.872

Notes: This table reports the change in average monthly sales between the matched merchants with and without contactless payment technology to the COVID-19 crisis in the period from 2019:01 to 2020:12 by essential sector. Panel A estimates equation (2) while Panel B estimates equation (3). The dependent variable is the logarithm of total monthly sales amount for each sector in columns (1)-(8). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). *Pre* is a binary variable that equals one for the two months of 2020 before the first containment (i.e., from 2020:01 to 2020:02), and *Post* is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). $Containment1$ is a binary variable that equals one for the months of the first containment (i.e., from 2020:03 to 2020:05), $AfterContainment1$ is a binary variable that equals one for the months after the first containment and the increase in the contactless payment limit (i.e., from 2020:06 to 2020:09), and $Containment2$ is a binary variable that equals one for the months the second containment (i.e., from 2020:10 to 2020:12). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

3.4 COVID-19 Crisis and New Customer Acquisition

After showing that the acceptance of contactless payment during the COVID-19 crisis actually helps merchants to better withstand shocks, I study the origin of the sales increase. There are several mechanisms through which I would expect the increase in the sales for merchants offering contactless payments. One plausible economic channel driving the sales growth lies in the role of the improved payment convenience in promoting retail traffic. As stated earlier, the contactless payment moves customer traffic more efficiently, especially for shops that concentrated in small transactions. Also, during the pandemic the fear that there is a risk of infection by the cash payment may cause consumers to explore new shopping venues. I postulate that consumers are more likely to explore new areas and shop at new stores offering contactless payment.

Using the same difference-in-differences specification, I find consistent results that the number of new customers, defined as cards that have never spent at the merchant in 2019, increased by 9.7 percent per month more for merchants offering contactless payment relative the control group (column (1) of Table 5). The effect is both economically and statistically significant at 1 percent level. Sales from new customers are 14 percent higher for stores that offer the latest payment technologies than for those that do not. The main acquisition of new customers occurs after the contactless payment limit is increased while continuing to the second containment. The placebo test shows that my results are very robust. Indeed, all coefficients $Treat \times Pre$ are statistically and economically insignificant. These findings suggest that the positive effect reflects true business growth rather than the substitution effect whereby consumers simply switch from cash to cards.

Table 5: Response of Sales from New Customers

	Log(Number of New Customers)		Log(Total New Customers Sales)	
	(1)	(2)	(3)	(4)
Treat x Pre	-0.003	-0.003	-0.007	-0.007
	(0.010)	(0.010)	(0.015)	(0.015)
Treat x Post	0.093***		0.131***	
	(0.009)		(0.013)	
Treat x Containment1		0.063***		0.090***
		(0.010)		(0.016)
Treat x After Containment1		0.094***		0.127***
		(0.009)		(0.014)
Treat x Containment2		0.123***		0.179***
		(0.010)		(0.015)
Constant	2.921***	2.921***	6.216***	6.216***
	(0.002)	(0.002)	(0.003)	(0.003)
Fixed Effects	Merchant, year-month			
Observations	417,024	417,024	417,024	417,024
R-squared	0.854	0.854	0.776	0.776

Notes: This table reports the change in average monthly sales from new customers between the matched merchants with and without contactless payment technology to the COVID-19 crisis (equations (2) and (3)) in the period from 2019:01 to 2020:12. The dependent variable is the logarithm of the number of new customers in columns (1)-(2) or the logarithm of total sales from new customers in columns (3)-(4). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). *Pre* is a binary variable that equals one for the two months of 2020 before the first containment (i.e., from 2020:01 to 2020:02), and *Post* is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). $Containment1$ is a binary variable that equals one for the months of the first containment (i.e., from 2020:03 to 2020:05), $AfterContainment1$ is a binary variable that equals one for the months after the first containment and the increase in the contactless payment limit (i.e., from 2020:06 to 2020:09), and $Containment2$ is a binary variable that equals one for the months the second containment (i.e., from 2020:10 to 2020:12). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

3.5 Substitution between Card Payments

In this section, I investigate the substitution between contactless and contact card sales before and during the COVID-19 crisis. It is indeed interesting to study how contactless card payments affect contact card sales, especially after the increase in the contactless payment limit. When a merchant accepts contactless payments, it can attract new customers who have a strong preference for the card. Consumers use contactless cards for small payments, for example, in place of cash, but perhaps also in place of contact cards. The number of contact card payments may then decrease if there is substitution between contactless and contact cards for small payments. Similarly, when contactless cardholders are loyal, when there is an increase in the threshold for contactless payment, they may also use the contactless card instead of the contact card, cheques, or cash for large amounts. Ultimately, compared to a merchant who has not yet adopted contactless payments, an NFC-equipped merchant may experience lower sales from contact card payments. That is exactly what I find as shown in Table 6.

The estimation results confirm the intuition described earlier. Using the matched difference-in-differences setting on the log of contact card sales, I find that even before the crisis there was a strong substitution between contactless and contact-card sales amount at about -11.1 percent[20] for merchants with contactless payment technology. This effect was increased with the COVID-19 pandemic. Indeed, during the first containment, where the limit of the contactless payment was 30 euros, the substitution accelerated to -24.6 percent. In the same vein, after the first containment and when the threshold for contactless payment reached 50 euros, contact-card sales decreased by -41.3 percent for merchants with the latest technology compared to those who still do not have it. The substitution between card payment methods remains so during the second containment. The estimation results are economically and statistically significant. The results are similar for contact card-sales count. The results suggest that during the COVID-19 pandemic, where social distancing was encouraged, consumers adopted the right behavior and followed government and banks recommendations to use contactless payment more intensively instead of contact card payment to stop the spread of infection. Increasing the contactless payment threshold by banking authorities also helps to accelerate the transition from contact to touchless payments.

[20]The estimated coefficient for log of card-sales amount on Table 6 is -0.118, which is equivalent to a percentage decrease of -11.1 percent (= exp(-0.118) – 1). All subsequent percentage effect interpretations for log dependent variables follow the same formula.

Table 6: Contact-Card Sales Response to the COVID-19 Crisis and the Increase in Contactless Payment Limit

	Log(Total Contact Card Sales Amount)		Log(Total Contact Card Sales Count)	
	(1)	(2)	(3)	(4)
Treat x Pre	-0.118***	-0.118***	-0.134***	-0.134***
	(0.003)	(0.003)	(0.003)	(0.003)
Treat x Post	-0.472***		-0.531***	
	(0.007)		(0.006)	
Treat x Containment1		-0.282***		-0.318***
		(0.009)		(0.008)
Treat x After Containment1		-0.533***		-0.601***
		(0.007)		(0.007)
Treat x Containment2		-0.581***		-0.651***
		(0.008)		(0.007)
Constant	8.847***	8.847***	5.424***	5.424***
	(0.001)	(0.001)	(0.001)	(0.001)
Fixed Effects	Merchant, year-month			
Observations	417,024	417,024	417,024	417,024
R-squared	0.938	0.938	0.934	0.934

Notes: This table reports the change in average monthly card contact sales between the matched merchants with and without contactless payment technology to the COVID-19 crisis (equations (2) and (3)) in the period from 2019:01 to 2020:12. The dependent variable is the logarithm of total monthly contact card-sales amount in columns (1)-(2) or the logarithm of total monthly contact card-sales count in columns (3)-(4). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). *Pre* is a binary variable that equals one for the two months of 2020 before the first containment (i.e., from 2020:01 to 2020:02), and *Post* is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). $Containment1$ is a binary variable that equals one for the months of the first containment (i.e., from 2020:03 to 2020:05), $AfterContainment1$ is a binary variable that equals one for the months after the first containment and the increase in the contactless payment limit (i.e., from 2020:06 to 2020:09), and $Containment2$ is a binary variable that equals one for the months the second containment (i.e., from 2020:10 to 2020:12). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

3.6 Evolution Toward Card Payments

In addition to acquiring new customers, the resilience of merchants equipped with the contactless payment technology to the COVID-19 crisis can also be explained by the substitution between card payments and the other means of payment. Here, I address this issue by using the experience of increasing the contactless payment limit to estimate the substitution effect. Note that, in order to halt the spread of COVID-19 infection, French banks had increased the contactless payment limit from

30 euros to 50 euros by mid-May 2020. Using this shock, I compare matched merchants over the period before and after the contactless payment limit increase using a similar difference-difference approach. The period before the payment limit increase will allow me to control for the effect that can be attributed to the COVID-19 crisis. It therefore serves as a reference period for the treatment group as well as for the control group. In addition, to better estimate the substitution effect that can be exclusively attributed to the increase in contactless payment limit, I keep only the sales made by loyal customers, i.e. I subtract the sales of new customers from the total sales. My analysis is based on the proposals put forward in section 2.2, in particular the proposition 2. Table 7 presents my main findings. I find evidence, after controlling for the effects of the COVID-19 crisis and eliminating new sales, that the increase in the contactless payment limit accelerates substitution between card sales and sales from other payment methods for merchants with contactless payment technology compared to those without it. Substitution is estimated by an average monthly increase of 3.5 percent in card sales amount from non-card sales amount (Column (1)). The coefficient is economically and statistically significant at 1 percent level. Substitution between card and non-card payments after the contactless limit increase is higher for both large merchants and new entrepreneurs. The actual effect is not attributed to the crisis nor to the attraction of new customers. This result is consistent with the European Central Bank survey which shows that card payments increase while cash payments decrease during the pandemic (European Central Bank, 2020b). Ditto for Jonker et al. (2020), who show that COVID-19 and the accompanying measures taken by the government and banks have modified consumer payment behavior and accelerated the shift in payment preferences towards contactless card payments.

Table 7: Substitution between Card and Non-card Sales after the Increase in Contactless payment limit

	Log(Total Sales Amount - Total New Customers Sales)		
	(1)	(2)	(3)
Treat x IncreaseLimit	0.035***	0.073***	0.031***
	(0.007)	(0.010)	(0.008)
Treat x IncreaseLimit x SmallMerchant		-0.027***	
		(0.011)	
Treat x IncreaseLimit x YoungMerchant			0.035**
			(0.016)
Constant	8.818***	8.818***	8.818***
	(0.002)	(0.002)	(0.002)
Fixed Effects		Merchant, year-month	
Observations	121,621	121,621	121,621
R-squared	0.932	0.932	0.932

Notes: This table reports the substitution between the sales from card payment and non-card payment after the increase of contactless payment limit in the period from 2020:03 to 2020:09. The dependent variable is the logarithm of total monthly sales amount minus total sales from new customers in columns (1)-(3). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). *SmallMerchant* is a binary variable equal to one for the small merchants, which is defined as merchants with median monthly sales lower than the 50th-percentile within each sector in 2019. *YoungMerchant* is is a dummy variable equal to one for the merchants less than 1 year old in 2019. *IncreaseLimit* is a binary variable that equals one for the months after the the increase in the contactless payment limit from 30 euros to 50 euros in mi-May 2020 (i.e., from 2020:06 to 2020:09). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

4 Robustness Checks, Full Sample, and Alternative Specifications

In the previous baseline regressions, I directly perform the placebo test by analyzing the non-significance of the coefficients associated with $Treat \times Pre$. In addition to this, in this section I intend to perform additional tests to further investigate the robustness of my main results.

4.1 Full Sample Analysis

I carry out the main analysis in the previous sections on a smaller sample in which the treatment and control units are matched on several observable merchant characteristics. To ensure that the results can be generalized to the full sample, I repeat my main analysis on the full unmatched sample using the difference-in-differences regressions. The results are reported in Panel A of Table 8. In the full sample, the treatment group (merchants with contactless payment technology) and the control group (merchants without contactless payment technology) differ observationally along several dimensions (Table 1). To address the challenge, I follow Agarwal and Qian (2014) and exploit the estimated propensity scores and include them as regression weights in the full unmatched sample difference-in-differences analysis. The rationale is to give a larger weight to those more similar merchants in the control group in estimating the counterfactuals after the shock. On the other hand, by using all treated merchants in the analysis, I will be able to speak to the external validity of my results in the matched sample analysis. I report the results in Panel B of Table 8. These results are consistent with my key findings regarding the resilience of merchants with contactless payment technology, the acquisition of new customers and the acceleration of substitution between contact and contactless payments, which further validates my research design.

Table 8: Card-Response in the Full Unmatched Sample

	Log of					
	Total Amount Sales	Total Count Sales	New Customers	New Customers Sales	Contact Amount Sales	Contact Count Sales
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Difference-in-differences regressions with the full unmatched sample						
Treat x Post	0.400***	0.401***	0.066***	0.177***	-0.009***	-0.091***
	(0.003)	(0.003)	(0.004)	(0.006)	(0.003)	(0.003)
Constant	9.574***	6.412***	4.147***	7.561***	9.253***	5.852***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Fixed effects	Merchant, year-month					
Observations	2,260,776	2,260,776	2,260,776	2,260,776	2,260,776	2,260,776
R-squared	0.934	0.943	0.853	0.755	0.929	0.926
Panel B: Weighted difference-in-differences regressions with the full unmatched sample						
Treat x Post	0.362***	0.355***	0.221***	0.330***	-0.038***	-0.128***
	(0.004)	(0.004)	(0.006)	(0.008)	(0.004)	(0.004)
Constant	9.702***	6.703***	4.375***	7.683***	9.317***	6.031***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Fixed effects	Merchant, year-month					
Observations	2,260,776	2,260,776	2,260,776	2,260,776	2,260,776	2,260,776
R-squared	0.943	0.937	0.843	0.782	0.941	0.933

Notes: This table presents robustness checks of the results shown in Tables 2, 5, 6 using the full unmatched sample. Panel A presents the full sample results with least square regressions. Panel B presents the full sample results with weighted least square regressions, using the propensity scores[a] as weights. The dependent variable is the logarithm of total monthly sales amount and count in columns (1) and (2), the logarithm of the number of new customers in column (3), the logarithm of total sales from new customers in column (4), or the logarithm of total monthly contact-card sales amount and count in columns (5) and (6). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). *Post* is a binary variable that equals one for the months after the first containment (i.e., from 2020:03 to 2020:12). All regressions include merchant and year-month fixed effects. Robust standard errors clustered at individual level are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

[a]Regression table is available upon request.

4.2 Cross-Sectional and Non-Parametric Estimations

Here, I investigate the robustness of my statistical inference and conduct the tests using alternative specifications as suggested by the literature review (Bertrand et al., 2004; Imbens, 2004; Abadie and Imbens, 2006). Bertrand et al. (2004) provide some evidence of standard error consistency issues in difference-in-differences estimates due to serially correlated outcome variables. Following Bertrand et al. (2004), I investigate the robustness of my inference. To do so, I collapse the time series information, for each merchant, by taking the average of the outcome variables in the pre-treatment and post-treatment periods. Then I regress, in the cross-section of merchants, the change in outcome variables (i.e., the change in sales and number of new customers) between the pre-treatment and the post-treatment period on a dummy variable for the treatment group indicator. I perform this exercise both on the matched sample (Panel A, Table 9) and on the full unmatched sample (Panel B, Table 9). Both tests give similar results to the original panel.

Abadie and Imbens (2006) point out the inconsistency of the standard errors for the matching estimators. Since my main analysis is performed on the matched sample based on nearest neighbor propensity score matching, I use the correction procedure proposed by Abadie and Imbens (2006). To do this, as before, I reduce the panel to a single cross-section and use the change in outcome variables between the pre-treatment period and the post-treatment period as dependent variables. Following the literature on non-parametric matching estimators (Imbens, 2004; Abadie and Imbens, 2006), I estimate the treatment effect based on the binary status of treatment group. I study two different specifications of matching estimators: nearest neighbor and radius with caliper. Results in Panel C-D of Table 9 show that merchants with contactless technology (the treatment group) respond robustly to the shock compared to merchants without contactless payment technology. Throughout the robustness tests, my main conclusions remain very similar and robust.

Table 9: Cross-Sectional Regressions and Non-parametric Estimations

	Change in monthly average					
	Total Amount Sales	Total Count Sales	New Customers	New Customers Sales	Contact Amount Sales	Contact Count Sales
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Cross sectional test in the matched sample						
Treat	0.064***	0.081***	0.143***	0.241***	-0.287***	-0.339***
	(0.005)	(0.005)	(0.019)	(0.061)	(0.005)	(0.004)
Constant	-0.076***	-0.076***	0.136***	0.342***	-0.076***	-0.076***
	(0.003)	(0.004)	(0.013)	(0.043)	(0.003)	(0.003)
Observations	17,376	17,376	17,376	17,376	17,376	17,376
Panel B: Cross sectional test in the full unmatched sample						
Treat	0.360***	0.383***	0.593***	0.870***	0.360***	-0.099***
	(0.003)	(0.003)	(0.012)	(0.028)	(0.003)	(0.002)
Constant	-0.076***	-0.094***	0.052***	0.310***	-0.076***	-0.094***
	(0.003)	(0.003)	(0.011)	(0.025)	(0.003)	(0.002)
Observations	94,199	94,199	94,199	94,199	94,199	94,199
Panel C: Non-parametric matching estimator: nearest neighbor						
Treat	0.165***	0.191***	0.199***	0.303**	0.165***	-0.291***
	(0.015)	(0.015)	(0.057)	(0.130)	(0.015)	(0.015)
Observations	94,199	94,199	94,199	94,199	94,199	94,199
Panel D: Non-parametric matching estimator: radius with caliper=0.01						
Treat	0.165***	0.193***	0.173***	0.177***	-0.223***	-0.290***
	(0.009)	(0.009)	(0.031)	(0.074)	(0.009)	(0.009)
Observations	94,199	94,199	94,199	94,199	94,199	94,199

Notes: This table presents robustness checks of the results shown in Tables 2, 5, 6 using alternative specifications. Panel A uses the matched sample and Panel B uses the full unmatched sample. Panel C-D, I use the non-parametric matching estimators to identify the average treatment effect. I compute the average monthly total sales and new customers during the months before treatment (2019:01-2020:02), and during the months after treatment (2020:03-2020:12) respectively. After I compute, as my dependent variable, the difference between the after-treatment average and before-treatment average for each merchant. Following Bertrand et al. (2004), I regress the dependent variables on a dummy variable for the merchants with contactless payment technology (Panel A-B). Following Imbens (2004), I use the nearest neighbor matching based on the estimated propensity score (Panel C). I next modify the matching algorithm by using radius matching with a 0.01 caliper (Panel D). The dependent variable is the change in monthly average total sales amount and count in columns (1) and (2), the change in monthly average new customers in column (3), the change in monthly average total new sales in column (4), or the change in monthly average contact-card sales amount and count in columns (5) and (6). *Treat* is a dummy variable for the merchants with contactless payment technology (treatment group). Standard errors are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels, respectively.

4.3 Synthetic Control Method

To further address the concern that matched control group may differ from matched treatment group in unobservable ways that may affect their sales behavior, I construct an alternative control group using the synthetic control method (Abadie and Gardeazabal, 2003; Abadie et al., 2010, 2012). This method allows me to attribute an estimated pre-treatment weight to each untreated unit. It involves constructing a weighted combination of untreated merchants used as controls, against which the treatment group is compared. Widely used when samples are small, synthetic controls provide a systematic way to select comparison units. To apply it, I first calculate the average log of total sales for each sector in the control and treatment groups for a given date. Next, I consider the set of sectors in the control group as the control units to which I assign an estimated weight using the pre-treatment period. Figure 4 plots the average log of total sales and count for the treated and synthetic control units. It shows a significant difference in sales between both groups after the first containment starting in March 2020. Using the synthetic control approach, I find that the treated unit is less impacted than the control group. This is consistent with my matching and difference-in-differences settings and provides further evidence of the robustness of my results.

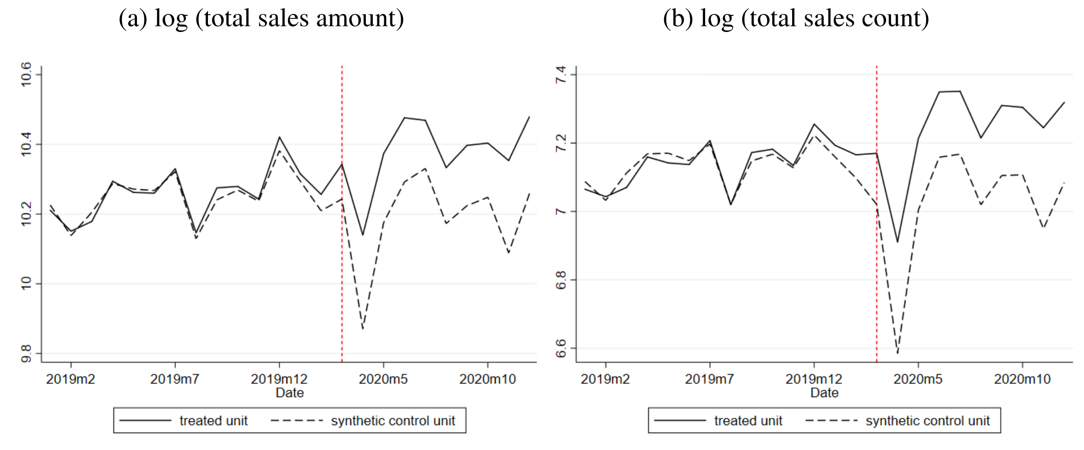

Figure 4: Synthetic Control Method

5 Conclusion

The aftermath of the COVID-19 pandemic has given a big boost to the fast-growing digital payments in the world. In order to reduce the spread of the virus through contact payments, people of all ages now seem to massively adopt and use contactless payments. As a result, consumers with contactless payment systems may prefer to make their purchases and increase their traffic at merchants using this technology in order to reduce physical contact, the process by which the coronavirus spreads. This paper addresses this thesis by investigating whether merchants with contactless technology experience more sales than those without. In doing so, it studies the impact of confinements in France on merchant sales using unique card transaction data from 94,199 French merchants covering the period from 2019:01 to 2020:12.

Using propensity score matching and difference-in-differences methods, I find that the card-sales amount (count) of merchants with contactless payment technology on average increases by

8.3 percent (10.2 percent) compared the merchants without this technology. I also find evidence that having contactless payments during COVID-19 helps attract more consumers and shift non-card payments to card payments. The acceptance of contactless payment is still promoting sales growth of merchants with the latest digital payment technology, especially small businesses and new entrepreneurs. Additionally, I show that the increase in the limit of contactless payment from 30 euros to 50 euros by French banks significantly accelerates the substitution between contactless payment and other means of payment for merchants with the latest digital payment relative to their counterparties. These results suggest the importance of contactless payment in mitigating the impact of epidemic shocks where social distancing is encouraged, acquiring new clients, and accelerating substitution with other payment methods.

Overall, the findings of the paper contribute to the literature on fintech and the digitization of cashless payments by shed new light on their real effect and ability to mitigate the impact of an epidemic shock. This could be fruitfully used to provide policy recommendations to policy makers, banks, and fintech companies interested in promoting efficient digital payment technologies.

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