Impact of Payment Service Directive I on Banks Performance in European Union

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ABSTRACT

In 2007, the European Commission announced the enactment of payment service directive, otherwise known as PSD1 which aims at providing more competition and regulatory symmetry across the European Union fragmented payment markets. PSD1 was the beginning of more disruptive regulations to come leading to Open Banking, the concept of banking on an open shared environment. Several governments around the world are considering Open Banking as a model for their respective industries, and it is perceived by media news as a threat, financial institutions, specifically banks should prepare for. To assess whether these threats are based on merits, our research looks at the impact of these directives on banks performance, starting from the first payment service directive in 2007. The results suggest a negative impact in the short-term, yet, the negative impact can be mitigated by strong regulatory support. Size and product offerings play a role in determining the magnitude of reaction to the directives and the future ability of banks to survive amid the changing environment. Banks should set strategic visions for future product offerings and define their strategies to be first-movers. Withstanding that, banks would be able to benefit from the disruptive future environment in the banking system.

1. INTRODUCTION

Evolution of technology and financial innovation

The evolution of technology in the past decade has been a fuel to the growth of financial innovation. Technology has become more accessible and widely used around the world. This has led to the development of innovative financial products such as e-money wallets, online payment accounts, mobile bank applications, etc. Banks would need to keep up the pace of their inventive bringing, to ensure that they survive in the fast-changing markets of today. Otherwise, complacency would lead to loss of competitive advantage and loss of customer base. As these newly created products continue to evolve, there's a need to regulate how they can be used, to what extent, and where they should be used. These innovative financial products are competing head-on with banks traditional products such as deposit accounts and credit cards. New players are entering the banking market with these low-cost creative offerings, and a need to provide regulatory framework is necessary to ensure fair competition and efficiency of operations. There are two approaches to regulation of these products. The first approach is by setting up regulatory bodies and national governments to dictate what rules should be applied and how markets should function, we call this the regulatory-based approach. The second approach is internal regulations developed by giant industry players according to their market needs and these regulations slowly diffuse between other peers until it becomes a standard practice in the industry, we call this market-based approach. There are arguments for and against each approach. A big question governments are currently tackling is whether Open Banking should be introduced by either of the two approaches or how can they combine the two approaches together. This paper addresses one regulation that came out in 2007, concerning payment and credit instruments across the European Union. The European Union, as opposed to North America, took the regulatory-based approach in PSD1 to ensure that information is symmetrical between all players in the payments market. The European Union did this through the formation of the European Commission which introduced the first Payment Service Directive in 2007. Following the internet bubble, the internet penetration increased significantly across years until it reached an estimate 55% penetration rate into households (Statista, 2006). Supported by this growth, there has been an explosion in the use of e-commerce among European consumers, with UK alone estimating £375.1 billion in online sales (Statista, 2005).Along this explosion, new financial players evolved. These financial players are called payment service institutions, whose function is to act as intermediary between customers and their banks to execute transactions online. Also, new products using electronic money evolved, such as e-wallets to facilitate payment process. This is an obvious benefit to customers. However, there are also risks associated with online payments. The common practice called Screen Scraping is used to execute these online payments. Screen scraping refers to the access to customer bank account data by third parties which use the relevant information to process payments (OpenBankingHub,2017). The main risk involved in screen scraping is the storage of customer credentials by third parties, posing a significant identity and cyber security risk. In addition to that, the lack of common regulation among all countries across EU led to regulatory arbitrage and inefficiencies in the payment markets that cost both money and time.

In 2007, the European Commission introduced the first Payment Service Directive, thereafter referred to as PSD1. The purpose of this directive was to provide a regulatory framework for the payments market, which will reduce inefficiencies and level the playing field between all stakeholders involved in the market. The PSD1 was part of SEPA (Euractiv, 2013), the effort to establish a Single European Payment Area between all state members to make payments market in European more efficient and profitable. This directive turns out to be one among many other laws yet to come that led to the development of Open Banking, a banking model that is bound to revolutionize the financial sector.

The Payment Service Directive (PSD)

The first payment service directive was introduced in 2007 with the aim to increase competition in the payments market, while providing the framework to ensure that cross border payments are as safe and efficient as national payments. The directive was part of SEPA, the Single European Payment Area initiative, which seeks to make the European Union a single market for payments. It was aimed at the three major payment alternatives to cash: direct debit, credit transfer and e-money instruments. The objective of regulators was to provide a legal framework to the use of these instruments to expand their use for online and offline purchases. The goal of regulation was not just to increase information symmetry across the EU, but also to encourage the use of these instruments by consumers, as an alternative to cash. The commission estimated that 3% of European GDP consists of cash-related expenses (Euractiv, 2013). By reducing the interchange fees charged by cardholder's bank to the merchant bank for each sale transaction, consumers and retail businesses can save up to €13.3billion annually (Euractiv, 2013). In addition to lowering fees and increasing transparency of information for customers, the second objective was to increase competition. The establishment of one single regulatory framework would eliminate any regulatory uncertainties between countries, and the existing payment institutions can gain from access to larger markets. The increase in competition would also drive innovation and push costs of payments downward, ultimately

making them competitive and efficient. The potential impact of this directive on banks is double sided. On one hand, the negative impact of PSD will be observed on three levels (EBA, 2008). The first level is practical impact on banks, which includes the direct competition with the innovative payment products and the need to change product offerings to become more competitive and customer focused. Also, there's investment costs associated with upgrading IT systems to comply with the faster execution times. The second level is strategic impact where the landscape in which banks operate in will change. There's a need to rethink strategy to become more digital. The tactical level encompasses all the internal changes the banks have to make to their documentations, additional training and staffing, and operational risk management to ensure full compliance with rules (EBA, 2008). The European Banking Authority itself views PSD as representing investment challenges to banks as they need to adjust their systems and technology to comply with the new requirements. On the other hand, the positive impact will derive from the standardization of payment processing, allowing banks to benefit from economies of scale, and therefore gain cost savings. Furthermore, the opportunity for innovation would increase substantially given the legal certainty associated with establishing standards into laws. (European Commission, 2012).

The credit implied in this regulation is not credit traditionally defined in the banking industry. That is, it is not the credit banks give by borrowing from the public using deposits and lending it out to the public as loans. Credit in the scope of the directive is defined as the short-term credit a payment institution can grant to clients to facilitate the use of payment instrument (European Commission, 2009). However, this form of short-term credit competes directly with the short-term loans traditional financial institutions offer to customers to finance their short-term expenditures.

The directive was drafted on November 13th, 2007, and its rules started applying as of November 1st, 2009. The payment instruments included in the directive are credit transfers, direct debits, card payments, mobile and online payments, and e-money (*European Commission, 2007*).

The inefficiencies that persisted prior the directive are the lack of economies of scale across the EU due to differences in legal framework for payments in country members. The EU moves around 52 trillion euros per year and significant cost savings can be generated if these payments are executed in bulk. There's a difference in processing times between country members. Execution time varied from being on the same day to taking at least three days (*Explanatory Memorandum to the Payment Services Regulations*, 2009). In the scope of PSD1, payment institutions are defined as non-bank payment service providers that offer credit or payment instruments such as credit cards, direct debits or e-money instruments. (*European Commission, 2009*). On the other hand, payment service providers include the e-money institutions, payment institutions and banks combined.

2008 Financial Crisis

In 2000, the UK conducted an investigation into the competitive environment in the banking industry. Among other findings of the report, some conclusions merit attention as it serves as an explanation as to why the retail banking market was not competitive. It was found that the existence of tight regulatory barriers were unnecessary, being not tied to the warranted levels of risks but rather mere attempts of protection to the industry (Cruickshank, 2000). Payment market was also found to be discriminately limiting access to money transmission. National payment schemes in UK were run by the large established banks, who denied access to the smaller payment providers, whose costs were prohibitively high in comparison. Additionally, the regulatory system that existed back then posed inefficient barriers to innovation for new entrants. New entrants such as financial technology firms which are more apt at innovation than larger banks were denied access to the market. This monopoly on payment market by large banks hindered the ability of customers to switch bank suppliers (Cruickshank, 2000). There's an inability to easily switch to the bank that offers the highest investment rate or lowest interest rate on loans, due to the redemption penalties imposed on loan borrowers and mortgage buyers, and the inability to current account prices across multiple banks. Banks were also found to be very protective of information to their consumers, suppliers as well as new entrants (Cruickshank, 2000). It was an extremely time-consuming process to look for account or loan alternatives. The result of these tight regulations was a very concentrated market for money transmission and payments in both consumer and small business markets. The regulator's recommendation based on these findings were a need for increase in information and transparency, a need for establishing the foundations of an e-commerce-based retail financial services and the need to increase the consumer protection laws. This report was conducted following the dot com bubble which occurred in 2000. Fast forward, eight years later, there was a meltdown of subprime mortgage market in the United States followed by a global deterioration in financial markets. This incident changed public trust levels in banks as well as regulators' view of financial services markets. The regulators observed the outcomes of a concentrated financial market. Following the introduction of Basel III, banks had to comply with more stringent capital and liquidity requirements. *Too Big To Fail* banks, which had large exposures to the US Mortgage backed securities shook public level trust in their governments after spending $2 trillion of taxpayers' money to bail these banks out (Harvard Business Review, 2018). Addressing the TBTF issue has been at the center of regulators' attention. It raises questions about the high barriers to entry in the industry, but more importantly the prudential concerns associated with systematic

failure of global economies which proved very costly to the economy. The main lesson to be learnt by regulators from the crisis was the need to increase the level of competition in the financial industry and enforce laws to foster innovation in a complacent industry. In Europe, since the financial crisis and the Euro crisis faced by state members, large banks reduced their lending activities to small medium enterprises due to tighter capital requirements Competition & Market Authority, 2016). This was an opportunity for new payment institutions to enter the lending market and gain some market share from the larger banks. In 2011, an updated market study on personal current accounts in UK reiterated the initial finding of the 2000 report. There persisted high levels to entry and expansion by smaller payment service providers. The increased dissatisfaction by customers from using the larger banks' personal current account offerings were enticing some customers to switch, but cost of information search was still high. Regulators finally came to the realization that new laws must be drafted to allow those new entrants more opportunity to grow and gain market share, and consequently improve the customer's banking experience.

The Current Account Mi Data Initiative

In 2011, Personal Current Account Mi Data Programme, a government-backed voluntary initiative was introduced to allow data exchange from banks to customers. It's a collaborative industry-government effort to increase sharing of personal customer data. The programme was diverse in its industry nature with 26 companies (Tomlinson,S., 2011) from technology, banking, payments, telecommunications and commodities industries signing up to become part of it. The initiative is aimed at allowing individuals to view, access and use their personal consumption and transaction data in a way that is portable and safe. This data portability feature allows customers to find better bank account deals or help them understand their spending habits. Midata is applied to any institution that provides personal current accounts, which may opt in the programme and is therefore mandated to make data available to customers to download, up to 12 months of transactions history. The transaction history can be submitted to price comparison websites which would recommend alternative product and service suites. Since its inception in 2011, it was gradually phased in. The objective of the programme resided on four pillars, which set the stage for the successive directives involved in data sharing *(Mitchell, A. (2012).*Data sharing is ought to be transparent, whereby the customer receives a comprehensive description of what data a company holds about them. Customers should be allowed access to their data whilst ensuring that secure mechanisms are used by banks to verify the identity of their customers. The critical aspect of this programme is giving customers control over their data, through being able to download, query or update their data whenever needed. In addition to control, customers should be able to transfer their data, like they transfer money from bank accounts, without constraints on the purposes of doing so. These four pillars address problems which exist in the consumer financial service market, proved by previous market investigation reports conducted by the government (Cruickshank, 2000). This programme proved successful to stimulate banks to embrace the open data sharing model. As a result of its success, the programme was adopted by other governments across EU as well as Australia. The initiative also addressed several key issues such as identity management, cyber security, data portability and data sharing. These issues motivated the industry and government to communicate more effectively and establish mechanisms to address these issues. Banks across the European Union came together and agreed on common standards to share data amongst themselves. These standards were defined for an open application programme interface, a software tool to communicate between banks' applications. In fact, in September 2015, HMT, a British governmental body announced the intention to deliver an open API standard in UK banking, which is referred to later as Open Banking (Open Data Institute, 2014). Following the announcement, the Open Banking Working Group was set up, at the request of HMT, to explore how data can be used to help people transact, save, borrow, lend and invest their money (TechUK, 2016). The OBWG later in 2018 set out an Open Banking Standard for how customers' data in banks should be created, shared and used by its owners and those who access it such as third party service providers.

General Data Protection Regulation (GDPR)

The General Data Protection Regulation is one of the key drivers that led to Open Banking in the UK. In 2012, the European Commission announced its commitment to reforming data protection across European Union to make Europe fit for the digital age (Palmer D., 2018). In essence, GDPR is a payment service directive for data protection. Its objective was to establish a simplified regulatory framework for safe and secure data sharing (European Commission, 2012). Companies were obligated to ensure the protection of data they collect and strictly use it for legal purposes, avoiding any misuse or exploitation, in which case companies must pay hefty legal penalties, as high as €20 million across EU. By creating a common framework for data sharing across EU, businesses will be able to benefit from cheaper and simpler operations, potentially saving up to €2.3 billion annually (European Commission, 2012). A revision of GDPR occurred in 2015 with the aim to strengthen the legal rights of customers across EU. The key aspects of the revised GDPR are data access, consent, right to data portability, data protection and privacy by design, whereby companies that hold customers' data are required to enforce technical standards to meet the proposed data security requirements (EU, GDPR, 2015). By revising GDPR, European Commission set the legal ground to maximize data protection for customers, before revising the first

payment directive. The customer's legal rights to data sharing in the context of the revised payment directive to come three years later are right to give only the minimum necessary data intended for the requested purpose, give explicit consent to share data, and right to consent withdrawal at any time upon the customer's request. The open API proposed to be implemented by OBIE would not have been possible to use without revising the GDPR and ensuring the clarity of customer's right to data portability, which is at the center of the open banking model.

The Second Payment Service Directive

Following the revision of GDPR in 2015, the first PSD was also revised into what is now called the second payment service directive, the directive that directly preceded Open Banking adoption in the EU. The transition period was shorter in PSD2 where banks were given only ninety days for rules to go into force and two years for rules to apply.

PSD1 was revised due to the proliferation of new payment instruments and the innovative solutions that surfaced in mobile and internet banking markets thanks to the rapid technology advancement (Worldline, 2018). The innovative products and service fell beyond the scope of PSD1 and therefore created a lot of uncertainty for both businesses and customers alike. The most important update in the second PSD is that the scope it uses to define payment institutions is far broader than PSD1 scope (European Commission, 2015). PSD2 included two new categories of PIs to account for the new players in the market. The first category called Account Information Service Providers, AISPs which are granted access to a customer's account, upon their consent, to verify their balances and information or more deeply view their transactions, analyze their spending behaviors and recommend personal financing solutions and budgetary services. The second category is Payment Initiation Service Providers, PISPs which are granted access to customers' account, upon their consent to initiate payments from their accounts, without the need for intermediaries (European Commission, 2015). Other aspects that were revised in PSD were the consumer rights whereby the consumers in PSD2 get unconditional refund rights. Also, the removal of credit card surcharge fees online and offline reduced the charging fees customers have to pay for their purchases. Finally, in case of unauthorized transactions, the customer is held liable for 50 euros only, instead of 150 euros that existed prior to PSD2 (European Commission, 2015). Authorization to account access has been more strictly defined in PSD2, to enforce the rights proposed by GDPR, and it's been defined as the responsibility of the financial institution to verify the identity of the third party providers requesting the data. However, the European Banking Authority, a government body set up to oversee the implementation of PSD2, will create a public central register of authorized payment providers which can be trusted with customer data. The EBA also oversees the development of strict technical standards on how authentication is given and the security of communication channels through which data is shared European Commission, 2015). Although the EBA oversees those technical aspects, it doesn't define the API standards payment providers should follow. These standards are rather left for the industry to agree on. The changes proposed by PSD2 are significant for financial institutions, as it signals the new wave of disruption to hit the industry. PSD2 widens the geographical scope of PSD1 by the introduction of one-legged transactions; where at least one party of the transaction resides within EU borders would be sufficient to enforce PSD2 laws. Banks in non-EU countries have to comply with PSD2 if the TPP requesting data access is located within EU borders. In other words, PSD2 can very much apply on a global scale. In addition to that, banks must comply and give away their customer data, given their approved consent, to the third party requesting it, which will in turn use it to provide more personalized products and services to the customer. In this sense, banks are giving away not only their future profit of potential customer acquisitions, but more importantly they are foregoing the raw data of financial behavior they collect on their customers. This commodity is the core of creating new financial products and services catered to customers' needs, and without it, new product innovations would become harder. Moreover, financial institutions would now face direct competition over client data with big technology companies such as Apple, Amazon, Google and Facebook, also known as GAFA. GAFA companies could possibly be third party providers; AISP or PISP, and they would request access to the customers' financial data to assimilate it further into useful product offerings. In fact, each of those big tech companies currently has their banking-related product offerings on the market and customers are at the early stage of their adoption. For example, Apple launched Apple Pay to make payment experience faster for customers at checkout, Facebook launched a Peer-to-Peer payment platform through which two customers can send money directly through Facebook Messenger application, Amazon launched Small Medium Business Lending platform to help small businesses finance their activities, and finally Google launched Google Wallet, an e-wallet to store bank account information on the cloud. The gravity of competition facing financial institutions is larger in PSD2 compared to PSD1. Considering the size and market share of the big technology companies worldwide,$3,102.6 trillion (Statista,2018), as opposed to the size and market share of global fintech industry, $105 billion in total funding (Forbes, 2016), the technology companies pose a larger threat than fintech companies. Notwithstanding the larger advantage technology companies have in customer engagement, banks are at a larger disadvantage compared to Tech companies. This perceived disruption to the industry contributes to the gaining popularity of the search term PSD2 compared to its predecessor, PSD1 shown in figure I.

Open Banking Standards

In January 2018, the Competition and Market Authority in UK published the first Open Banking standards developed by OBIE in the world, enforced only on the largest nine banks in UK, known as CMA9. The nine largest banks are HSBC, Danske Bank, Barclays Bank, Royal Bank of Scotland, Lloyds PLC, Santander Bank, Nationwide Building Society, Allied Irish Bank Group and Bank of Ireland. The standards refer to the pre-defined set of technical standards of a single application programme interface to be implemented by CMA9.

The difference between PSD2 and Open Banking lies mainly in the way API standards are defined. In PSD2, the technical standards of API were left for markets to define whereas in Open Banking, the standards were pre-defined by regulators. This difference in approach would affect the reaction of banks to each set of laws. Although the first pre-defined Open Banking API came out in the UK, banks across EU were sharing data across their subsidiaries and with PSPs using an industry defined common standard called NextGenPSD2. It remains ambiguous whether all EU banks will voluntarily apply to use the UK-developed API or they would continue using NextGenPSD2. In contrast to PSD2, Open Banking transition period was shorter with only two months to implementation of the API. The shorter transition time would affect the reaction the announcement of the respective laws. Despite the shorter time to implementation, banks should be more ready to transition to the new API proposed in Open Banking law due to their previous expertise in developing NextGenPSD2.

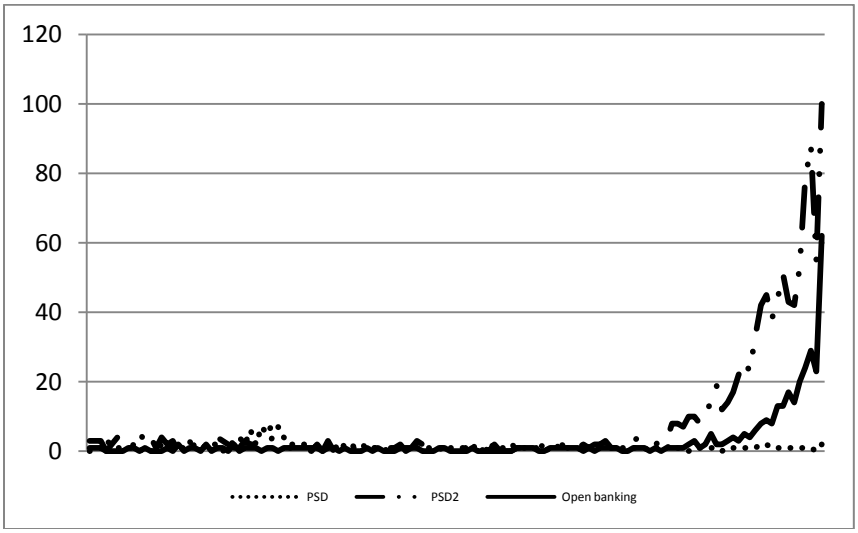

Figure I: Google trends for search terms PSD I, PSD II, Open Banking. PSD I gained very little interest across time which would also explain why there's not any financial literature about the topic. PSD2 is more popular as a search term compared to PSD2 and this may be attributable to the increased competition expected from PSD II. Open Banking shadows PSD II in its popularity and it may explain why non-financial customers use the two terms interchangeably.

3. HYPOTHESES

There's no literature review cited in this paper due to the absence of any previous research done on this topic in financial journals. The possible reason for lack of academic interest in the topic of PSD is the timing of its introduction in 2007. The law was enacted in 2007 and its rules started applying in 2009. Those two years were at the heart of the global great financial crisis in 2008. The negative consequences of the crisis might have veiled the impact of PSD1, making research far more difficult to conduct. However, in order to understand Open Banking and how it would potentially impact banks, it is important to date the law from its starting point, in which case it is the PSD1. The reason being the high correlation observed among abnormal returns of the three directives: PSD (I), PSD (II) and Open Banking shown in figure II.

All these laws mentioned in the introduction were aimed at increasing competition with banks and disrupting their markets. We attempt to look at whether this argument of perceived threat to banks is warranted. If the threat of disruption is warranted, then those directives should negatively impact banks' performance.. The negative impact stems from the

increased costs of compliance, which would also encompass the investment costs in IT and systems. The caps proposed by the European Commission on interchange fees will reduce the revenues earned by banks. However, there is also the upside impact from the cost savings banks will accumulate as they benefit from economies of scale in payment processing and payment accounts, and the greater access to European market. The two views are justified. However, the negative impact felt on banks due to higher compliance costs might be a short-term effect but in the medium to long run, the costs savings would manifest. We defined the short-term to be one year after the enactment of PSD1, the medium term was defined as three years following the announcement, and long-term is five years following the directive. We decided to test the negative impact from announcement of PSD1 on the market. In financial research, the impact of an event can be measured using two different approaches. The market-based metrics include price changes and return differences. The accounting-based metrics include change in operating performance proxied by Return on Assets, as an example. Market-based metrics are more volatile, and subject to substantial white noise. However, returns change instantly in reaction to events, these changes could be abnormal or normal. These instant reactions are useful to help isolate the effect of events. On the other hand, the accounting-based measures are more stable, but isolation of impact of certain events is far more difficult, as accounting information is reported on a quarter or annual basis. If the two approaches yield the same result, it signals that the market understood the impact of the event clearly. The market correctly predicted the effect on banks in the medium to long-term. Our first two hypotheses test the two approaches.

Hypothesis I: The enactment of PSD1 would have a negative cumulative abnormal return effect on the banks across the EU countries, in the short-term.

Hypothesis II: Banks would experience reduced operating profit as a result of lost market share and higher compliance costs, in the short-term.

Hypothesis III: Large-sized banks are able to better survive in the anticipated increase in competition and costs of compliance, and would therefore react less negatively to PSD1 compared to smaller-sized banks.

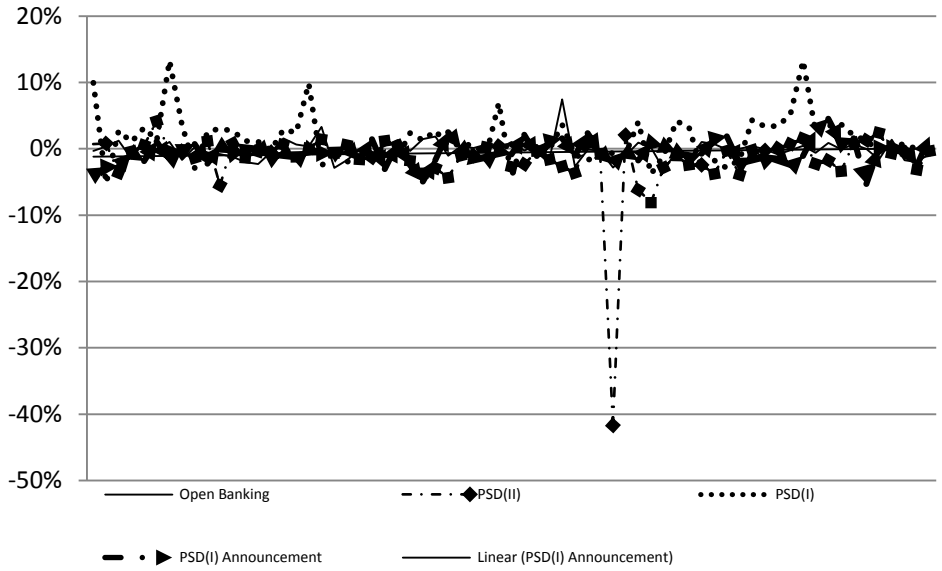

Figure II: The cumulative abnormal returns are highly correlated among each other for each of the directives; PSD I, PSD II and Open Banking. PSD I is slightly out of the cycle but the day of its announcement follows a very similar pattern to abnormal returns of PSD II and Open Banking.

4. DATA DESCRIPTION

Our initial sample size is 347 financial institutions, including banks, securities firms, mutual/thrift/savings funds and insurance underwriters based in the European Union. We narrowed down the sample to companies identified as banks, as PSD1 and all the directives to follow tackle this type of financial institution more than the others. The resulting sample size is 193 banks which all are located in Europe. We downloaded the entire SNL Europe database to obtain financial information about our sample banks. For hypothesis #3, the outstanding deposits number was needed as a proxy for measuring size. To obtain the price of banks stocks, we use Bloomberg database for historical prices dating back to 2007. Banks which were had available deposit information in SNL database and available price information on Bloomberg were only included in the final sample. This narrowed down the sample from 193 banks to 67 banks, in total. The reason for other banks not to exist on Bloomberg is that some were delisted or suspended from trading and others were not publicly tradable on an exchange. It's important to acknowledge the small size of our final sample. However, the sample includes 18 different European countries out of which banks are based which give us ample diversity to capture differences across European Union. Figure II show the distribution of banks in our sample. Return differences were calculated based on prices obtained from Bloomberg Database and operating performance measures such as ROA and ROE were also obtained from Bloomberg Financial Analysis. To measure competition, we include two variables obtained from the European Central Bank Statistical Data Warehouse. The first variable is the number of payment and credit institutions domestically incorporated in one country. The variable is measured as the outstanding number of firms at the end of the year, in our sample it is 2007. The second measure is the total number of debit, credit and e-money cards issued by payment service providers including banks. This reflects the readiness of banks to capture the potential market share in the payments market, primarily in retail banking. The distribution of the number of cards issued and total deposit across countries is shown in figure IV.

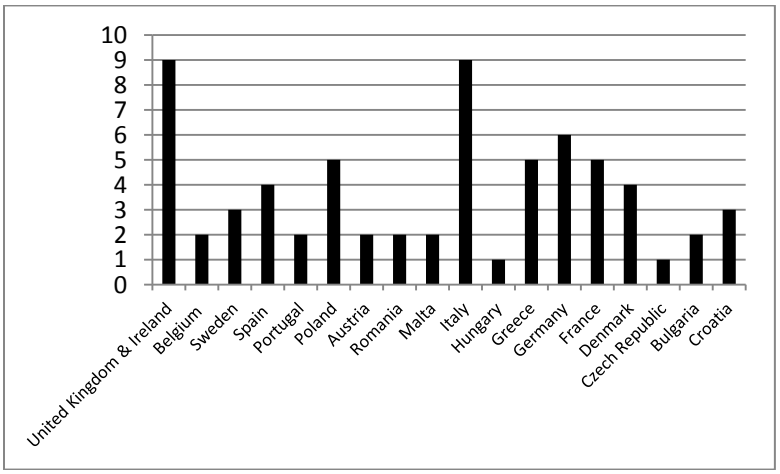

Figure III: distributions of banks across sample. Some EU countries were excluded due to the lack of trading activity of their banks. Banks in Britain and Northern Ireland are combined together. From Hungary and Czech Republic there is only one bank tradable of 2007. The average bank from each European country is 3.72.

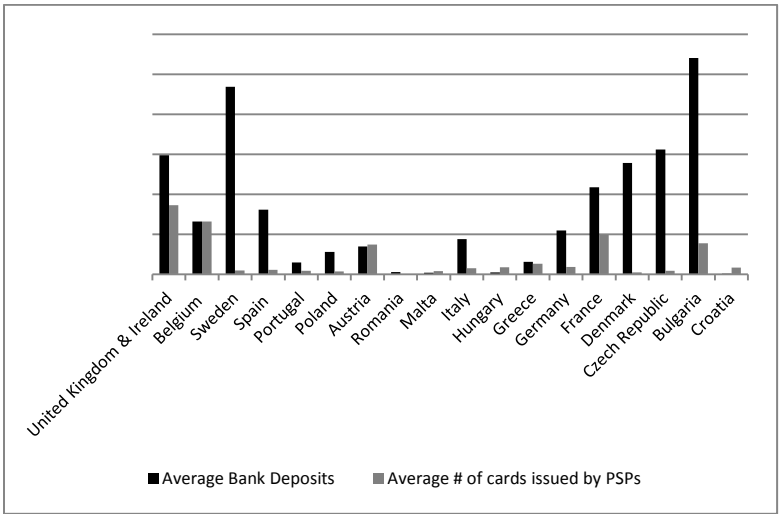

Figure IV: Distribution of total deposits and number of cards issued by PSPs including banks across 18 EU countries. There's some pattern in the distribution of the two variables across the eighteen European countries in our sample. Some countries have equal weight of both deposits and cards such as Belgium and Austria, which is a less observed pattern across the eighteen countries. The more dominant pattern is the larger deposits compared to the number of cards issued in the country. Some countries such as Czech Republic and Sweden have significantly small number of cards issued relative to their deposits. In the analysis below, we discuss whether these two variables are mutually exclusive or one variable can compensate for another.

5. MODEL

Event study is a one of the most popular statistical designs in Finance. It allows researchers to test the impact of certain events on firms, and also measure the size of the impact of market-wide events such as regulations on firms individually or the market as a whole. This methodology is pertinent to our research question, given our goal is to assess the impact of PSD1 on firm's stock prices and operating performance. The initial procedure in an event study is to define the reference date, the date upon which the market receives the event news. There are four different dates associated with PSD1. The first date is March 27th, 2007 the day in which the term first circulated the news about its approval. The second date is November 13th, 2007 the day in which the PSD1 law was drafted. The third date is December 25^{th,}, 2007 in which the laws went into force. The last date is November 1st, 2009 in which the PSD1 rules start applying. In previous research done using the same methodology to test regulatory changes, it is not clear the exact time frame through which enforced laws take place Henderson, G. (1990). The change due to regulations takes place in a process where changes are gradually enforced across time rather than at a specific point in time. Therefore, we will test the dates on which PSD1 was announced, that is March 27th and the day the law was drafted, that is November 13th, 2007. The issue with the presence of multiple dates is the banking market could have reasonably anticipated the PSD1 news before they even circulated the media. In the introduction, we outlined how directives are usually introduced based on collaboration between regulators and industry. There are no news indicating that PSD1 was collaboratively introduced like PCA Midata Initiative. Thus, we will assume that the law was introduced without any direct collaboration with the industry. The second parameter we define in event study is the event window. The event window is the event day plus and/or minus numbers of days when the firms' returns are observed to see if an abnormal return occurred. In our model, we run the event study based on a one-day window, the day of the event plus and minus one day before and after the announcement. There's no unanimity on the length of event window. The length represents a tradeoff between white noise and market efficiency. On the one hand, the shorter windows are more accurate to assess event impact but could also represent white noise not related to the event, if the event is previously anticipated by the market and the information is already incorporated into the stock price. On the other hand, the wider windows would allow more time to assess impact of event, but it will be at the cost of accuracy. In our model, we choose shorter windows to study the two event dates as opposed to a wider window which includes the two dates, 231 days apart. The shorter window will allow us to gauge impact more accurately and give insights about the impact perceived by the market as time passes. In terms of expected returns, we assumed the firms will earn the same return as the market index, absent any news. This is a reasonable assumption given the short horizon of our window. Market-adjusted return, for each day is calculated and aggregated across sixty seven firms. We aggregate the sum of abnormal returns across three days and calculate the cumulative abnormal return for each bank.

Let t-0 represent the time of the event. For each bank in the sample, the returns on the stock price for time period t+1, t and t-1 relative to PSD1 donated as

$Rit = Kit + eit$

where Kit is the market index return and eit is the abnormal return determined by market reaction to the event announcement. The equation can be rewritten as a function of excess return that is equal to the difference between the actual return observed and the expected return:

$eit = Rit - Kit$

$CER\ (t1, t-1) = \sum ER\ t$ where t=0, t-1,t+1

6. EMPIRICAL RESULTS

The first event window we run is based on March 27th,2007. The day corresponds to the first time PSD term circulated the press news about its approval. The cumulative abnormal return is -0.5620% with standard deviation 1.8505%, from table I. The mean AR one day before the event is -0.5330%, one the event day is 0.2320% and the day after the event is -0.2410%. One day before the event announcement, the market return is significantly volatile, with 3% std deviation and 26% range. This rise in volatility could reflect the uncertainty associated with the approval of PSD1 by European Union. It's also possible that an exogenous variable spiked volatility of the market and therefore induced volatility on the abnormal return of that day as well. On the day of the event, market returns were also volatile, 2.64% std deviation and 22% range whereas bank returns were more stable with 1.29% std dev and 8% range. The day following the event, market return stabilized and along with banks returns the AR was negative. This is more likely a more accurate assessment of impact of PSD1 compared to the results we got one day prior to the event. The reason being assuming the confounding effect which induced volatility across EU market was dissipating on the day of the event, the following day was a negative abnormal return, in reaction to PSD1 approval. The following date, November 13th, 2007 when the directive is drafted into law is also run to compare the reaction to the law following the passage of 231 days. Between the two dates, the abnormal returns are more stable on November 13th compared to March 27th. The mean CAR is 1.3934% with std dev 3.57%, from table II. The positive return could reflect the change in sentiment about PSD1 after the law was drafted. The laws were enforced based on three time periods and they come into effect two years later, on November 1st 2009. In essence, the European Commission gave banks two-year transition period to comply with the new rules. This transition period calmed the market and banks alike and caused a positive abnormal return cumulatively and on the day of drafting the law. The AR on November 13th is 0.494% with std dev 1.64% and range 10%. The bank returns were significantly more volatile than market returns, which is consistent with the logic where banks have far more uncertainty than the general market as to how the new laws would apply. The day prior to the announcement, both the market and the banks were anticipating the drafting of the directive positively, indicating an expectation from regulators that the directive is reasonably setting a timeline for changes to be enforced. The day following the enactment, the markets reacted more positively than banks and less volatile. PSD1 benefits consumers and other players in the market more than banks, which would explain the larger positive returns. The smaller effect on banks is a result of the continued negative impact associated with cost compliance and the need to plan future investments in the two years ahead. The positive return for banks may point to the larger role uncertainty played in the directive enactment compared to the increased costs.

For PSD2, we run the event study based on the date November 25th,2015 when the second directive was drafted. The second directive is broader in scope and imposes a larger competition on banks compared to PSD1 as it opens up direct threat with Big Tech companies like GAFA. In addition to that, the implementation timeline for PSD2 is approximately similar to that of PSD1 so banks do not have additional time to accommodate to the new more stringent rules. Based on that, we expect the PSD2 to have a larger negative impact on banks and a larger positive impact on the market given the larger benefits it brings to consumers and PSPs. The mean CAR for PSD2 is -1.6550% and std dev 5.40%, from table III. On the day the law was drafted, the abnormal return reaches a -1.35% and 3.53% std dev., with the increased volatility from bank stock returns. Additionally, the market reacted more positively and accumulated 0.34% gain over the day compared to 0.03% in PSD1. The volatility in abnormal returns in PSD2 is induced by volatility in bank returns as opposed to market returns which averaged 1% std dev across the three days. Following the day of the enactment, the abnormal return is -1.18% and a positive market return 0.74%,which is a more negative abnormal return than PSD1 and a more positive market return than PSD1. The day prior to the announcement of revision, the market return is -0.37% with std dev 0.69% whereas bank return is 0.51% with std dev 4.67%. The negative reaction by the market could be explained by increased uncertainty of whether a revision in PSD2 would favor banks more than customers. When the directive is revised and the laws favored more competition and consumer protection right, the market corrected the negative returns.

Open Banking was introduced on January 13th, 2018. The day corresponds to the day PSD2 rules started taking effect. There's reason to believe that there exists industry regulation collaboration prior to introducing Open Banking. The reason being the fact that prior to Open banking, EU banks were using a common API for the industry. With the introduction of Open Banking, the standards for API are defined by the Open Banking Implementation Entity, which significantly shifts the risk from industry to regulators as it is OBIE who defines the standards for API environment through which customers'

data will be shared. Although investment costs, risk of competition and loss of customer data still exists, the standardization of API environment would provide more certainty and would potentially outweigh the increased costs. On the other hand, Open Banking has a shorter timeline to compliance with rules and the largest nine banks in the UK were obliged to use the pre-defined API for data sharing. This would negatively impact bank. However, the use of common API prior to Open Banking would hedge this risk of incompliance as it would be replacing the existing API with the OBIE-defined API. After running the model on the Open Banking announcement date, we observe a -0.11% mean CAR with 1.55% std dev, from table IV. The mean CAR is less negative than PSD2, pointing to the reduced risks associated with the law in light of defining API standards by regulators. The existence of collaboration between regulators and industry to introduce Open Banking would also contribute to the improved reaction to Open Banking in comparison with PSD2. This result highlights the importance of collaboration between regulators and industry in introducing disruptive laws such as PSD and Open Banking. Prior to OB, the API used to transact data included within the scope of PSD2 is a commonly defined standard by industry players. The market is left to decide the security standards, environment and access to API for data sharing and regulators kept an eye on how the market was advancing. This allowed more room for innovation by banks which understood market needs better and at the same time gave banks the chance to change their strategies to accommodate for the use of API. The commonly defined standard was called NextGenPSD2. Following January 13th, 2018 the API standards were defined by regulators, after knowing the set of standards all market agreed on and correcting for its weaknesses. The European Commission in fact took both the market-based approach and regulatory-based approach to define these standards. This sets an example of how Open Banking can be introduced in markets such as USA and Canada. In our sample, there are 7 out the 9 CMA banks in UK which were obligated by law to comply with Open Banking laws. The rest of the EU market could voluntarily adopt the OBIE standards. We isolate those 7 banks from the original sample to observe whether their reaction to Open Banking laws would differ compared to the rest of the EU banking market. The results of the CAR and AR(t) are shown in table V. CMA7 CAR is 0.15% with 0.95% std dev where on the other hand the rest of 59 banks have a CAR -0.15% and std dev 1.61%. The difference in direction of CAR indicates that pre-defining API standards by regulators significantly reduced uncertainty to the nine largest banks and led to a positive return. The rest of the market, on the other hand, is at a disadvantage as they would have to work with silos between the two API standards and customers would prefer to have their data shared over the regulator-defined standards which are more likely safer. Additionally, the CMA7 alone have average deposits €537,072,217 whereas the 59 banks without CMA7 have average deposits €113,066,788. The smaller banks are at a larger cost disadvantage to switch to OBIE-defined API if they wish. The difference in reaction between CMA7 and the rest of the market points to the size advantage larger banks has which plays a role in assessing the impact of such regulations. This advantage merits a separate hypothesis to be tested on its own, hypothesis #3. In regards to hypothesis #1, we are able to prove that the initial reaction to laws such as PSD1, PSD2 and Open Banking is negative, in the short-term horizon of three days. The reduced uncertainty associated with longer implementation deadlines and collaboration between industry and regulators in defining API standards contribute to the less negative reaction over time. Test of mean equality using standard t-values were initially conducted on each of the return variables. However, the assumption of independency between returns doesn't hold especially for PSD1 when a confounding effect was forcing a negative reaction across the EU market and causes increased volatility. This induced volatility in CAR would not lead to conclusive results for mean equality tests. The next process in this methodology is to fit a generalized autoregressive conditional heteroskedastic model, known as GARCH model to compare the significance of the abnormal returns. The GARCH model would be used to estimate variance of excess returns on the day of the event, using three years of historical returns. The excess returns over the market would be compared to estimated variance of excess returns. The larger the return over the variance, the more significant the event is on both the bank and market returns. GARCH models are time-consuming and given the limited time to write this paper, we consider it as a next step to verify our results.

In addition to measuring impact using abnormal returns over three-day period, we also use the change in operating performance to assess the impact from an accounting perspective. To proxy for operating performance, we use Return on Asset reported by banks annually. The change in ROA is taken as the difference between ROA reported in 2006, one year prior to PSD1 and 2008, one year following PSD1. The rules of PSD1 go into force on December 25th, 2007. Therefore, we use a one-year period to assess the change in performance. As we stated in our hypothesis #2, we expect the short-term performance to deteriorate due to compliance costs and changes in banks IT structures.

The change in performance in one-year period is -0.60567, from table VI, a similar direction to the CAR for PSD1. The result indicates that the market correctly predicted the impact on operating performance of banks due to PSD1 compliance, in the short-term. It also supports our hypothesis #1 that the PSD1 in the short-term would result in a negative impact on banks. However, the year after the announcement of the law, the financial crisis erupted globally and negatively affected banks in European Union as these banks had considerable exposure to subprime mortgage market and the derivative products on them. Although it is logical to assume that the new directive would put pressure on profitability of banks, it is hard to isolate the effect as the financial crisis effect is far bigger and has more likely overshadowed the PSD1 effect.

According to the timelines set, PSD1 rules start applying in 2009, so the change in ROA performance is calculated across three years from 2006 to 2009. The mean ΔROA based on the three year window is -0.33, almost 50% lower than the one-year ΔROA. Again, the negative impact could possibly be caused by PSD1, but the crisis effect is still large. Therefore, hypothesis #2 might hold, but with the crisis effect, we take this conclusion with a grain of salt. In addition to that, studying the impact of PSD1 in the medium to long-term would be difficult as the successive ten years were an expansion in the economic business cycle. Even if five to ten years later, there's an improvement in ROA, it would not be accurate to contribute it to PSD1 taking its positive effects.

From table V, the observed average deposits of the largest 7 banks in UK alone is 4.75x larger than the average deposits of the remaining 59 banks spread across European Union. The larger sized banks are able to comply faster and cheaper compared to smaller-sized banks whose cost structures are larger and more outspread. Based on this argument, the size of banks would affect their reaction to PSD1 enactment in 2007, hypothesis #3.

There are multiple measures of size for a firm. The two most relevant measures for our sample are total deposits and total assets. We use total deposits for regression analysis as it is a more accurate estimate of size to a bank. The larger deposits a bank has the larger its customer base is and the larger its reach is across EU. To verify whether total deposits explain CAR observed on November 13th, 2007, we run a OLS regression model which turns out to have an R squared 10.42%, from table VII . The model is significant at 1% level and total deposits significantly explain the variation in cumulative abnormal returns observed across the three-day window. A €1 million increase in deposits will increase cumulative abnormal returns by 0.00488%. Replacing CAR by ΔROA (1) yields a model that is significant at 30% with and R squared 1.89% , as shown in table VIII. This result is driven by the negative effect on ROA caused by the crisis. Banks have to absorb huge losses in their asset values for bad loans on their balance sheet so both their net incomes and assets shrank significantly. The €1 million increase in deposits causes the ROA to decrease by 0.071. Large-sized banks have larger deposits compared to small-sized banks. The deposits are loaned out to the public in the traditional banking model of operation. The larger deposits, the more loans the banks lend out to the public and the larger the exposure to the financial crisis impact. In regards to hypothesis #3, the regression model supports our argument that deposits, a measure of size impacts the reaction of banks to PSD1 law with large-size banks reacting more positively than small-sized banks.

Among other purposes, PSD1 is introduced to increase the level of competition in the payments industry and allow more entrants into the market. Therefore, it is logical to include a measure of the competition that exists prior to the introduction of the first payment service directive. In previous literature, measures of competition include the number of firms in a market or the market share of the top 10 firms, as a measure of concentration. The two measures of competition we obtained are number of payment institutions domestically incorporated and the number of cards issued by payment service providers, including banks. The number of cards issued by PIs is not a direct measure of competition per se, it is more likely a measure of potential market share to be captured by the domestic payment service providers, including banks. We run a regression model to assess whether the two additional variables can explain the variation in cumulative abnormal returns observed, in addition to total deposits. The regression model is shown in table IX. The overall model is significant at 5% level. The combined explanatory power of the three variables is 12.09%. Total deposits and number of cards issued are both significant at 5% level. However, the number of payment institutions variable is not significant. The estimated coefficient for the variable results in 0.031% decrease in cumulative abnormal returns for each 100 payment institutions. This observation points to the insignificance of competition to the cumulative abnormal return reaction to PSD1. The threat perceived by banks from increased competition is not merited given the bank is well-positioned to capture the increase in potential market share of payment services. A large-sized bank with $1 million in deposits in a market of $1 million cards issued will react to PSD1 positively with CAR equal to 0.019% . By replacing the CAR with Δ ROA(1), the results, shown in table X, hold as for regression 2. The crisis effect shadowed the observable effect of PSD1. However, the direction of both total deposits and cards issued were consistent with previous regression run with ROA(1). 1 million new cards issued contribute to 0.22 increase in ROA. 1 million new cards issued and $1 million increase in deposits will increase ROA by 0.14. If payment service providers issued cards issued in 2007, despite the financial crisis, they would still be able to capture the potential increase in market share.

7. ROBUSTNESS

We run the event study model on March 27th, 2007 for wider event window to assess the robustness of our results. Wider windows that yield significant results indicate the significance of PSD1 on abnormal returns observed. As argued earlier, test of mean equalities will not be conducted on excess returns due to the induced-volatility effect. We only look at the direction of cumulative abnormal returns to conclude if the result is consist based on the three event windows, 3, 7 and 11 day-periods. The mean CAR is -1.01% with std dev 4.13% for the seven-day window and -1.37% with std dev 7.36% for the 11-day window, shown in table XI. The anticipated negative impact before the law is drafted and implementation timelines are clearly defined spread persistently across time in the market. The negative returns and higher volatility are

driven primarily by bank returns reflecting the increased uncertainty. In our discussion above, we concluded the presence of an exogenous factor that drove increased volatility on market returns, but not bank returns. In two alternate windows, the bank returns were consistently negative and more volatile than market returns. This suggests that even in the presence of exogenous variable on March 27th which may have caused the negative cumulative returns, the consistence of negative returns in the two alternate event windows may suggest the dominance of uncertainty around the payment service directive. As an alternate measure of size, total assets are used instead of total deposits in the regression model. The results are shown in table XII. The results obtained from regression model 3 in table IX are robust and hold with total assets as measure of size. In fact, total assets better accounts for the variation in cumulative abnormal returns with an R squared 24.87%. $1 million increase in deposits for each 1 million cards issued increases cumulative excess returns by 0.021%. For ΔROA, the results in table XIII indicate a slight improvement in model significance at 15%, and a slight improvement in explanatory power, 3% using total deposits and 6% using total assets as measure of size. An increase in assets cause a larger decline in operating performance compared to total deposits. Although these measures are alternatives, the presence of more assets suggests a stronger association with loans. Loans should be more associated with assets as bank assets are in essence loans whereas deposits can be used for other purposes not limited to lending such as fulfilling reserve requirements. Nevertheless, the results of the regression are consistent with our previous findings. The third robustness method we use is winsorization to cumulative abnormal return means. In figure II, there's a large downward spike in cumulative returns for PSD II. There are two higher peaks in PSD I cumulative return distribution. If winsorized means give the exact results as tables I to IV, this suggests that even after removing outliers, the reaction to the directives hold. As shown in table XIV, both PSD II and Open Banking cumulative excess returns hold their direction, indicating the robustness of our previous conclusions.

8. CONCLUSIONS AND FUTURE DIRECTIONS

The growth in innovative payment solutions and the entry of new players into the payment and credit market enticed regulators to introduce a more robust regulatory framework, to ensure that information among new and existing players is symmetrical. The first payment service directive aimed at doing just that. In 2007, the wave of disruption in the banking industry started first by enactment of PSD1, followed by the Mi Data PCA initiative, the revision of GDPR , the revision of the directive into the second payment directive. The sequence of these regulations led to the introduction of Open Banking, a new operating model for banks whereby data is shared in an open environment. Disruption doesn't lie solely in the new operating model, but rather in the intense competition banks are expected to face from titans of technology in the world. Although the short-term reaction to these directives is negative, the regulatory support offered in giving transition periods to implementation, understanding market needs and giving room for market innovation to prosper would reduce the negative impact and consequently lead to benefits to banks. Our research tested only the short-term impact of the PSD1, defined as one year. The European Commission introduced Open Banking in a combined regulation-market based approach which proved successful at reducing uncertainty associated with the laws. Due to the financial crisis in 2008, the medium-long impact would be difficult to isolate and test. However, the improvement in reaction we observed in our sample across time gives us some insights to the possibility of positive impacts going forward. The wave of disruption that started was anticipated, thanks to the rise in technological innovation in finance. Large-sized banks are able to survive and prosper more in the competitive environment. Nonetheless, small-sized banks would be able to survive as well, given the readiness to capture potential market share of future products. This brings in the strategic vision of a bank's management C-suite which must anticipate the direction of digital disruptions and react accordingly by being first movers in said market segments. Although the 2008 financial crisis was very costly to regulators and consumers alike, it gave opportunity for more payment institutions in European countries to rise and bring their innovative offerings to the market.

For future direction, we would be interested to know what the effect of these directives is on the Fintech- payment service providers including both account information providers and payment initiation providers, and the effect on big technology firms such as GAFA. We would expect our conclusions to be reversed, in favor of these directives but there will also be certain characteristics of these firms which would allow some to benefit more than others.

9. APPENDIX

Return	Mean	Median	Standard deviation	Variance	Range
CAR	-0.5620%	-0.6570%	1.8050%	0.0326%	9.8270%
AR (t-1)	-0.5530%	-0.3240%	3.1960%	0.1020%	27.8990%
AR (t+1)	-0.2410%	-0.2140%	1.4200%	0.0202%	8.7270%
AR (t)	0.2320%	-0.0530%	2.6400%	0.0697%	22.2170%
MR (t-1)	-0.2480%	-0.9720%	3.1220%	0.0974%	25.6680%
MR (t+1)	-0.5490%	-0.5730%	0.4940%	0.0024%	2.4730%
MR (t)	-0.0410%	0.3710%	2.5640%	0.0657%	20.9980%
R (t-1)	0.1914%	0.3087%	1.2940%	0.0167%	8.4080%
R (t+1)	-0.7900%	-0.8310%	1.1610%	0.0135%	8.1920%
R (t)	0.1914%	0.3087%	1.2940%	0.0167%	8.4080%

Table I: Descriptive statistics on return variables for Payment Service Directive 1 based on March 27th, 2007.

Return	Mean	Median	Standard deviation	Variance	Range
CAR	1.3934%	1.0296%	3.5700%	0.1270%	18.4670%
AR (t-1)	1.0701%	0.6130%	2.0960%	0.0439%	12.2000%
AR (t+1)	-0.3390%	-0.2140%	1.4200%	0.0202%	8.7270%
AR (t)	0.4941%	0.4763%	1.6420%	0.0270%	10.5020%
MR (t-1)	0.1452%	0.4111%	1.0000%	0.0100%	4.4400%
MR (t+1)	1.5425%	1.5567%	0.7130%	0.0051%	2.9460%
MR (t)	0.0307%	0.0098%	0.6220%	0.0039%	2.6790%
R (t-1)	1.2153%	1.0113%	2.4330%	0.0592%	12.7460%
R (t+1)	1.2031%	1.2315%	1.6750%	0.0281%	9.5010%
R (t)	0.5249%	0.6518%	1.7650%	0.0311%	11.3370%

Table II: Descriptive statistics on return variables for Payment Service Directive 1 based on November 13th 2007.

Return	Mean	Median	Standard deviation	Variance	Range
CAR	-1.6550%	-0.6420%	5.3970%	0.2910%	45.8850%
AR (t-1)	0.8810%	0.2447%	4.2440%	0.1800%	28.1130%
AR (t+1)	-1.1840%	-0.2240%	4.3420%	0.1890%	28.2060%
AR (t)	-1.3520%	-0.7740%	3.5340%	0.1250%	22.1840%
MR (t-1)	-0.3740%	-0.4680%	0.6930%	0.0048%	2.4530%
MR (t+1)	0.7416%	0.8906%	0.4270%	0.0018%	1.5670%
MR (t)	0.3414%	0.6149%	1.0470%	0.0110%	3.5120%
R (t-1)	0.5080%	-0.2270%	4.6700%	0.2180%	29.3840%
R (t+1)	-0.4420%	0.4650%	4.5150%	0.2040%	29.1760%
R (t)	-1.0110%	-0.2880%	3.9920%	0.1590%	23.9800%

Table III: Descriptive statistics on return variables for Payment Service Directive 2.

Return	Mean	Median	Standard deviation	Variance	Range
CAR	-0.1140%	-0.0850%	1.5560%	0.0242%	10.5720%
AR (t-1)	-0.1590%	-0.0480%	1.0920%	0.0119%	6.6500%
AR (t+1)	0.0900%	0.0230%	1.3030%	0.0170%	8.0950%
AR (t)	-0.0450%	-0.0480%	0.7660%	0.0059%	5.0980%
MR (t-1)	0.0493%	0.0762%	0.3910%	0.0015%	2.1260%
MR (t+1)	-0.0560%	-0.1060%	0.2610%	0.0007%	1.3530%
MR (t)	0.2536%	0.2537%	0.1990%	0.0004%	1.1420%
R (t-1)	-0.1090%	-0.1810%	1.1650%	0.0136%	6.3870%
R (t+1)	0.0338%	0.0000%	1.3400%	0.0180%	8.9030%
R (t)	0.2083%	0.2494%	0.7460%	0.0056%	4.5950%

Table IV: Descriptive statistics on return variables for Open Banking based on January 13th 2018.

	Return	Mean	Median	Standard deviation	Variance	Range
CMA7	CAR	0.1486%	0.3548%	0.9530%	0.0091%	2.5210%
	AR(t)	0.0750%	-0.2650%	1.3250%	0.0176%	3.9270%
	Average deposits	€537,072,217				
Without CMA7	CAR	-0.1450%	-0.1120%	1.6140%	0.0261%	10.5720%
	AR (t)	-0.0590%	-0.0340%	0.6890%	0.0048%	3.8000%
	Average deposits			€113,066,788		

Table V: Summary statistics of CAR and AR(t) for Open Banking event including CMA7 together and rest of the market excluding CMA7 banks. CMA7 banks in the sample are Royal Bank of Scotland, Lloyds Bank, HSBC Group, Barclays Group, Danske, Santander Bank and Bank of Ireland.

Return	Mean	Median	Standard deviation	Variance	Range
Δ ROA (1)	-0.6057	-0.4800	1.2224	1.4942	10.3400
Δ ROA (2)	-0.3267	-0.2800	0.9981	0.9963	8.7100

Table VI: Change in operating performance of banks due to the first Payment Directive.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Model	0.00876	0.00876	7.56	0.0077
Intercept	0.00667	0.00493	1.35	0.1807
Total Deposits	4.88E-11	1.78E-11	2.75	0.0077
R-Square	0.1042			
Adj R-Sq	0.0904			

Table VII: Regression Model 1. The CAR is dependent variable and total deposits per bank is the explanatory variable.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Model	1.85952	1.85952	1.25	0.2678
Intercept	-0.49983	0.1766	-2.83	0.0062
Total Deposits	-7.11E-10	6.36E-10	-1.12	0.2678
R-Square	0.0189			
Adj R-Sq	0.0038			

Table VIII: Regression Model 2. The ΔROA (1) is dependent variable and total deposit per bank is the explanatory variable

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Model	0.0135	0.0045	3.98	0.0117
Intercept	0.00273	0.00735	0.37	0.7114
Total Deposits	4.01E-11	1.80E-11	2.23	0.0296
Total Number PIs	-3.09E-06	7.59E-06	-0.41	0.6859
Cards issued	1.47E-10	7.22E-11	2.04	0.0453
R-Square	0.1615			
Adj R-Sq	0.1209			

Table IX: Regression Model 3. The CAR is the dependent variable and total deposit per bank, number of cards issued by payment institutions and total number of credit and payment institutions are the explanatory variables.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Model	2.77334	1.38667	0.92	0.4053
Intercept	-0.6031	0.21017	-2.87	0.0056
Total Deposits	-8.02E-10	6.58E-10	-1.22	0.2273
Cards issued	2.20E-09	2.64E-09	0.83	0.408
R-Square	0.0283			
Adj R-Sq	0.0026			

Table X: Regression Model 4. The ΔROA (1) is the dependent variable and total deposit per bank and numbers of cards issued by payment are the explanatory variables.

	Return	Mean	Median	Standard deviation	Variance	Range
7-day window	CAR	-1.0140%	-0.8750%	4.1300%	0.1710%	30.1270%
	AR(t)	1.5019%	1.5053%	4.0500%	0.1640%	26.0670%
11-day window	CAR	-1.3720%	-0.6440%	7.3760%	0.5440%	47.9750%
	AR (t)	1.7311%	1.0384%	6.7080%	0.4500%	49.6080%

Table XI: Descriptive summary of return variables based on a 7-day and 11-day windows. This table should be compared with Table I and Table II for robustness.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Model	0.02154	0.01077	11.59	<.0001
Intercept	-0.00149	0.00521	-0.29	0.7751
Total Assets	1.77E-11	5.47E-12	3.24	0.0019
Cards issued	1.88E-10	6.78E-11	2.77	0.0074
R-Square	0.2722			
Adj R-Sq	0.2487			

Table XII: Regression Model 5. The dependent variable is CAR and independent variables are total assets, instead of total deposits, and number of cards issued by payment institutions.

Variable	Parameter Error	Standard Error	t Value	Pr > |t|
Model	6.06025	3.03013	2.05	0.1379
Intercept	-0.55123	0.20792	-2.65	0.0102
Total Assets	-4.27E-10	2.18E-10	-1.96	0.0549
Cards issued	2.51E-09	2.71E-09	0.93	0.3577
R-Square	0.0619			
Adj R-Sq	0.0316			

Table XIII: Regression Model 6. The dependent variable is ΔROA (1) and independent variables are total assets, instead of total deposits, and number of cards issued by payment institutions.

Cumlative Abnormal Returns	Percent winsorized in tail	Number winsorized in tail	Winsorized mean	Std Error of winsorized mean
PSD I	10.45	7	1.0589%	0.3359%
PSD II	10.45	7	-1.0320%	0.2565%
Open Banking	10.45	7	-0.1740%	0.1540%

Table XIV: Two tail winsorized means on the cumulative abnormal returns. 10.45% is winsorized from each variable for robustness.

References:

- *Payment Services Directive: The new payments landscape. (2013). Retrieved from https://www.euractiv.com/section/euro-finance/linksdossier/payment-services-directive-the-new-payments-landscape/*
- *EUR-Lex - 52011DC0941 - EN - EUR-Lex. (2012). Retrieved from https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52011DC0941*
- *Explanatory Memorandum to the Payment Services Regulations. (2009). [Ebook]. Retrieved from http://www.legislation.gov.uk/uksi/2009/209/pdfs/uksiem_20090209_en.pdf*
- *Payment services. (2007). Retrieved from https://ec.europa.eu/info/business-economy-euro/banking-and-finance/consumer-finance-and-payments/payment-services/payment-services_en#eu-rules-on-payment-services*
- *Banks Preparing for PSD: A Guide for Bankers on the Payment Services Directive. (2008). Retrieved from https://www.abe-eba.eu/media/azure/production/1342/banks-preparing-for-psd.pdf*
- *The Good, The Bad and The Ugly Of PSD2 | Protiviti - Canada. (2018). Retrieved from https://www.protiviti.com/CA-en/node/143656*
- *CMA-Competition & Markets Authority. (2016). Retail banking market investigation [Ebook]. Retrieved from https://assets.publishing.service.gov.uk/media/57ac9667e5274a0f6c00007a/retail-banking-market-investigation-full-final-report.pdf*
- *PSD2, what is behind the updated directive?. (2018). Retrieved from https://worldline.com/en/home/blog/2017/july/psd2-what-behind.html*
- *PSD2 - What changes? (2016). Retrieved from https://www.finextra.com/blogposting/12668/psd2---what-changes*
- *Revised rules for payment services in the EU- Summary. (2018). Retrieved from https://eur-lex.europa.eu/legal-content/EN/LSU/?uri=CELEX:32015L2366*
- *Henderson, G. (1990). Problems and Solutions in Conducting Event Studies. The Journal of Risk and Insurance, 57(2), 282-306. doi:10.2307/253304*
- *Kothari, S., & Warner, J. (2004). The Econometrics of Event Studies. SSRN Electronic Journal. doi: 10.2139/ssrn.608601*
- *What do PSD1 and PSD2 mean and why are they important?. (2018). Retrieved from https://blog.ibanfirst.com/en/what-are-psd1-and-psd2-and-why-are-they-important*
- *Lamdin, D. (2001). Implementing and interpreting event studies of regulatory changes. Journal Of Economics And Business, 53(2-3), 171-183. doi: 10.1016/s0148-6195(01)00035-2*
- *Corrado, C. (2010). Event Studies: A Methodology Review. SSRN Electronic Journal. doi: 10.2139/ssrn.1441581*
- *Dnes, A.W., Kodwani, D.G., Seaton, J.S. et al. Journal of Regulatory Economics (1998) 13: 207. https://doi.org/10.1023/A:1008027419553*
- *Open Banking year one: Insights from the CMA9 and more. (2019). Retrieved from https://www.finextra.com/newsarticle/33194/open-banking-year-one-insights-from-the-cma9-and-more*
- *Open Banking Guidelines for Read/Write Participants. (2019). Retrieved from https://www.openbanking.org.uk/wp-content/uploads/Guidelines-for-Read-Write-Participants.pdf*
- *Retail Banking Market Investigation. (2019). Retrieved from https://assets.publishing.service.gov.uk/media/57ac9667e5274a0f6c00007a/retail-banking-market-investigation-full-final-report.pdf*
- *Why Big UK Banks Are Worried About Open Banking. (2019). Retrieved from https://www.forbes.com/sites/baininsights/2018/03/15/why-big-uk-banks-are-worried-about-open-banking/#499336614450*
- *Why Big Banks Are Losing To Tech Giants Over Open Banking. (2018). Retrieved from https://www.forbes.com/sites/ginaclarke/2019/01/10/why-big-banks-are-losing-to-tech-giants-over-open-banking/#4deed8013a57*
- *Addressing the differences between Open Banking and PSD2. (2019). Retrieved from https://www.fintech.finance/01-news/addressing-the-differences-between-open-banking-and-psd2/*
- *Manifesto-for-the-impact-of-PSD2-on-the-future-of-European-Fintech pdf. Retrieved from* https://futureofeuropeanfintech.com/

- *Basso, A., Bon, J., Tasker, B., Timan, N., Walker, M., & Whitcombe, C. (2018). Recent Developments at the CMA: 2017-2018. Review of Industrial Organization, 53(4), 615–635.* https://doi-org.lib-ezproxy.concordia.ca/10.1007/s11151-018-9668-2
- *Sinclair, S. (2013). The EU wants a wide-open banking system. We should say No. CCPA Monitor, 20(3), 6. Retrieved from https://www.policyalternatives.ca/publications/commentary/eu-wants-wide-open-banking-system-we-should-say-no*
- *Cruickshank, D. (2000). Competition In UK Banking [Ebook] (pp. 35-43).*
- *Retail banks 'aren't competitive'. (2011). Retrieved from https://www.bbc.com/news/business-12935228*
- *The future of competition and regulation in retail banking. (2017). Retrieved from https://www.fca.org.uk/news/speeches/future-competition-and-regulation-retail-banking*
- *midata for personal current accounts. (2011). Retrieved from* http://www.pcamidata.co.uk/
- *Mitchell, A. (2012). From data hoarding to data sharing. Journal Of Direct, Data And Digital Marketing Practice, 13(4), 325-334. doi: 10.1057/dddmp.2012.3*
- *Personal current accounts Market study update. (2014). [Ebook]. Retrieved from https://assets.publishing.service.gov.uk/media/53c834c640f0b610aa000009/140717_-_PCA_Review_Full_Report.pdf*
- *Estimated e-commerce sales value in the UK 2009-2016 | Statistic. (2005). Retrieved from https://www.statista.com/statistics/474534/estimated-e-commerce-sales-value-in-the-uk/*
- *Household internet access in the European Union (EU28) 2007-2017 | Statistic. (2007). Retrieved from https://www.statista.com/statistics/377585/household-internet-access-in-eu28/*
- *Screen scraping 101: Who, What, Where, When?. (2017). Retrieved from https://openbankinghub.com/screen-scraping-101-who-what-where-when-f83c7bd96712*
- *Basel III: international regulatory framework for banks. (2013). Retrieved from https://www.bis.org/bcbs/basel3.html*
- *The Financial Brand. (2018). Five Innovation Trends That Will Define Banking in 2019. [online] Available at: https://thefinancialbrand.com/77869/innovation-trends-banking-ai-api-personalization-payments*
- *The Social and Political Costs of the Financial Crisis, 10 Years Later. (2018). Retrieved from https://hbr.org/2018/09/the-social-and-political-costs-of-the-financial-crisis-10-years-later*
- *Tomlinson, S. (2011). 'midata' is coming - what will your business do with it?. [online] Available at: https://www.soprasteria.co.uk/docs/librariesprovider41/White-Papers/sopra-steria-midata-is-coming7d3f6a94e93c64d785faff0000851219.pdf?sfvrsn=6b030e5a_4*
- *Data Sharing and Open Data for Banks A report for HM Treasury and Cabinet Office. (2014). [ebook] Available at:https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/382273/141202_API_Report_FINAL.PDF*
- *(techUK), L. (2016). HM Treasury publishes report of the Open Banking Working Group. [online] Techuk.org. Available at: https://www.techuk.org/insights/news/item/7451-open-standard-application-programming-interface-api-in-banking*
- *What is GDPR? Everything you need to know about the new general data protection regulations. (2018). [Blog] ZDnet. Available at: https://www.zdnet.com/article/gdpr-an-executive-guide-to-what-you-need-to-know/*
- *European Commission - European Commission. (2012). Data protection. [online] Available at: https://ec.europa.eu/info/law/law-topic/data-protection_en*
- *Statista. (2018). Biggest companies in the world 2018 | Statista. [online] Available at: https://www.statista.com/statistics/263264/top-companies-in-the-world-by-market-value/.*
- *Forbes.com. (2016). The Global Fintech Landscape Reaches Over 1000 Companies, $105B In Funding, $867B In Value: Report. [online] Available at: https://www.forbes.com/sites/jeanbaptiste/2016/09/28/the-global-fintech-landscape-reaches-over-1000-companies-105b-in-funding-867b-in-value-report/#50fc14c626f3.*