THE EFFECTS OF OPEN BANKING ON FINTECH PROVIDERS: EVIDENCE USING MICRODATA FROM SPAIN

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Abstract

Open banking initiatives, which aim to increase competition and innovation in the financial sector by enabling the customer-authorised sharing of financial data among banks, regulated third-party providers and other financial stakeholders, are becoming widespread around the world. This paper investigates the impact of open banking on the development of the fintech sector, focusing particularly on payment-related financial services. We utilise the implementation of the Second Payment Services Directive (PSD2) in Europe as a natural experiment and employ a difference-in-differences methodology to analyse a unique microdata set of 406 Spanish fintech firms from 2014 to 2022, sourced from the Banco de España Central Balance Sheet Data Office and Fintech Radar. Our findings reveal that following PSD2, fintech firms specialising in payment services (Paytech) improved their performance compared with non-payment fintechs (control), with this improvement driven primarily by revenue growth rather than cost reduction. Additionally, treated fintech firms exhibited a significant reduction in long-term bank debt reliance, securing more stable market-equity funding. We also find that Paytech firms increased their liquidity holdings, reduced their labor intensity while increasing their labor costs and enhanced their productivity. Our results contribute to the literature on open banking by providing empirical evidence of its benefits for fintech firms, particularly in the payment sector, and underscore the importance of regulatory frameworks in fostering innovation and competition. These insights are valuable for policymakers aiming to enhance financial sector dynamics through data-driven regulations.

Keywords: open banking, fintech, payments, PSD2.

JEL classification: L22, G23, C63.

Resumen

Las iniciativas de banca abierta —que tienen como objetivo aumentar la competencia y la innovación en el sector financiero al permitir el intercambio de datos financieros autorizado por el cliente entre bancos, proveedores terceros regulados y otros actores financieros— se están extendiendo por todo el mundo. Este documento investiga el impacto de la banca abierta en el desarrollo del sector *fintech,* centrándose particularmente en los servicios financieros relacionados con los pagos. Utilizamos la implementación de la Segunda Directiva de Servicios de Pago (PSD2, por sus siglas en inglés) en Europa como un experimento natural y empleamos una metodología de «diferencias en diferencias» para analizar un conjunto de microdatos único de 406 empresas *fintech* españolas, desde 2014 hasta 2022, obtenido de la Central de Balances del Banco de España y Fintech Radar. Nuestros hallazgos revelan que, tras la PSD2, las empresas *fintech* especializadas en servicios de pago *(paytech)* mejoraron su desempeño en comparación con las *fintech* no especializadas en pagos (grupo de control), avance impulsado principalmente por el crecimiento de ingresos en lugar de por la reducción de costes. Además, las empresas *fintech* tratadas mostraron una reducción significativa en su dependencia de la deuda bancaria a largo plazo, con lo que aseguraron una financiación más estable a través del mercado de capitales. También encontramos que las empresas *paytech* incrementaron su liquidez, redujeron la intensidad laboral al tiempo que aumentaron sus costos laborales y mejoraron su productividad. Nuestros resultados contribuyen a la literatura sobre banca abierta al proporcionar evidencia empírica de sus beneficios para las empresas *fintech,* particularmente en el sector de pagos, y destacan la importancia de los marcos regulatorios para fomentar la innovación y la competencia. Estos conocimientos son valiosos para los responsables de políticas que buscan mejorar la dinámica del sector financiero a través de regulaciones basadas en datos.

Palabras clave: *open banking, fintech,* pagos, PSD2.

Códigos JEL: L22, G23, C63.

1. Introduction

Data is at the core of today's businesses. This is especially true in the financial industry, where data drives decision-making, innovation, and the development of personalized services. Historically, banks have functioned as closed systems, maintaining strict control over customer data and services. However, the emergence of open banking has significantly disrupted the status quo. The core of open banking initiatives is the secure and efficient sharing of financial data from bank customers with third-party providers through application programming interfaces (APIs). In recent years, numerous open banking initiatives have been introduced globally to enhance competition within the financial services sector. These initiatives aim to facilitate data sharing, improve payment services, and prevent fraud. According to Babina et al. (2024), up to 80 countries have considered some form of open banking policy, with 49 having implemented final policies.

Among third-party providers, fintech firms stand out as significant beneficiaries of these open banking initiatives, particularly those specializing in payment services. The rise of financial technology has been one of the most transformative trends in the financial industry in recent years (Jagtiani & Lemieux, 2018). Fintech firms offer innovative digital solutions that incumbent financial institutions do not always provide and thus have the potential to reshape the financial landscape (Cornelli et al., 2023). With authorized access to bank data, fintech firms can directly benefit from open banking regulations, primarily by offering payment and account aggregation services. The potential impact of such regulatory changes is particularly relevant in the current competitive landscape, ranging from reducing operational costs to lower margins, especially as fintech firms emerge as disruptors of the traditional banking industry (Feyen et al., 2021; Frost et al., 2019). However, there is still a lack of research on the impact of these open banking initiatives. There is a particular gap in the literature regarding how regulation affects the development of the fintech ecosystem (Cornelli et al., 2023; Ehrentraud et al., 2022).

In this paper, we empirically analyze the effect of open banking on fintech providers. Using microdata from a representative sample of the Spanish fintech ecosystem, we examine the impact of the adoption of an open banking framework on firms that benefit from accessing bank customers' data to offer payment-related financial services. In line with previous studies (Cologgi, 2023; Polasik et al., 2020; Preziuso et al., 2023), we use the implementation of the Second Payment Services Directive (PSD2) in Europe as our empirical setting. This payment-focused open banking regulation, approved in 2016 and coming into force in January 2018, aimed to enhance digital payment security through, inter

alia, strong customer authentication (SCA) and a set of Regulatory Technical Standards (RTS), and additionally granted third-party providers (TPPs) access to customers' data to initiate payments. Given that PSD2 was designed to increase competition and promote the growth and strengthening of the payments sector, we focus on its effects on performance and access to funding as indicators of growth, strength, and financial independence. Additionally, we examine the broader economic impact of this open banking initiative, including its effects on investments, cash holdings, employment, and productivity.

To do so, we employ a difference-in-differences (DiD) methodology. Our fintech-level dataset is built by combining various sources of information. The accounting data is sourced from the Bank of Spain Central Balance Sheet Data (CBI – microdata on individual enterprises), which provides extensive and granular balance sheet information for millions of non-financial Spanish companies from the Spanish Mercantile Register. To identify fintech firms within this dataset, we cross-referenced it with a list of fintech companies identified in the FinTech Radar, a census of fintech firms developed internally at the Bank of Spain (Sánchez & Quintanero, 2022), and the Spanish non-bank fintech entities dataset. Both datasets were obtained from the repository of the Bank of Spain Data Laboratory (BELab).[1] This process yielded a final sample of 406 Spanish fintech firms spanning the period from 2014 to 2022. For our DiD analysis, the focus of PSD2 on offering secure payment services provides an ideal setting to identify fintech firms directly affected by the regulation (*Paytech fintech*). Fintech firms not impacted by the regulation serve as a control group (*Non-Paytech fintech*). This unique setting allows us to explore the effects of adopting an open banking framework at the fintech level.

This paper contributes to two areas of the literature. Firstly, it contributes to the literature on open banking. Previous studies have demonstrated that open banking improves access to financial services for households and small-to-medium-sized enterprises (Babina et al., 2024; Nam, 2023), promotes financial inclusion (Fang & Zhu, 2023), and fosters competition (Polasik et al., 2020). Additionally, open banking improves fintech firms' screening abilities, leading to greater informational efficiency in borrower selection (He et al., 2023). Regarding the adoption of these initiatives, consumer trust and privacy concerns in data sharing are critical (Babina et al., 2024; Bijlsma et al., 2023; Parlour et al., 2022; Polasik & Kotkowski, 2022). While the existing literature on open banking provides valuable insight into its immediate effects on financial markets and consumer behavior, several research gaps

[1] The Bank of Spain Data Laboratory (BELab) was created with the aim of providing the research community with improved access to high-quality microdata in a controlled environment that ensures data confidentiality. Data is accessed on-site or remotely, depending on its sensitivity level. https://www.bde.es/wbe/en/para-ciudadano/servicios/belab/

remain. This paper contributes to the literature by providing empirical evidence regarding the effect of open banking on the growth and dynamics of third-party providers (fintech firms).

Secondly, our paper contributes to the literature on the fintech ecosystem. Previous studies have highlighted how fintech companies are disrupting traditional financial services by introducing innovative business models and enhancing the efficiency and accessibility of financial products (Berg et al., 2022; Boot et al., 2021; Philippon, 2018; Vives, 2019). The fintech phenomenon is influenced by multiple factors, including the high cost of financial services (Philippon, 2018) and uncompetitive banking markets (Claessens, Frost, et al., 2018; Frost, 2020). Furthermore, research indicates that the emergence of fintech firms is driven by a favorable economic climate (Haddad & Hornuf, 2019), the presence of technology clusters (Laidroo & Avarmaa, 2020), and ample sources of investment and financing (Brandl & Hornuf, 2020; Haddad & Hornuf, 2019). While existing literature has examined the factors contributing to the performance of these new competitors (Andrikopoulos & Dassiou, 2024; Carbó-Valverde et al., 2022; Salerno et al., 2022), there is limited research on how regulation shapes the development of the fintech ecosystem. Our paper addresses this gap by providing empirical evidence on how data-driven financial regulations can influence the growth of new financial service providers. In doing so, we aim to contribute to two streams of the fintech literature. Firstly, we add to studies that analyze the growth dynamics and capital structure of fintech firms. Secondly, we contribute to research examining how regulations affect fintech firms' performance. Understanding this regulatory impact can offer valuable insight into the competitive advantages of fintech firms compared to traditional financial companies and their implications for financial stability (Daud et al., 2022; Vučinić, 2020).

By way of preview, our findings indicate that following the implementation of PSD2, fintech firms in the treatment group experienced a 23% improvement in return on assets (ROA) compared to the control group. This improvement is primarily driven by the income-growth channel rather than cost reduction. Our heterogeneity analysis shows that the positive impact on performance is less pronounced for larger, more solvent (highly capitalized), and more indebted (highly leveraged) firms. Regarding access to funding, treated fintech firms rely, on average, approximately 10% less on total bank debt than the control group, mainly due to a reduction in their reliance on long-term bank debt. In terms of economic output, treated fintech firms invest less in both intangible and tangible assets while maintaining a larger proportion of current (more liquid) assets. Additionally, treated firms have reduced labor intensity but increased labor costs, leading to a boost in productivity. Furthermore, treated fintech firms demonstrate an ability to secure more stable funding. Among fintech

firms that have successfully secured market funding, treated fintech firms have raised a higher volume of funds. These results withstand several robustness checks, including tests for anticipatory effects, random treatment, different subsamples, and various definitions of treated firms.

Our findings are valuable for policymakers and stakeholders aiming to foster innovation and competition in the financial sector through data-driven financial regulations. By running impact assessments such as this one, regulatory bodies are able to make informed decisions and evaluate the real outcomes of new policies. In our setup, open banking frameworks could complement other policy interventions, such as regulatory sandboxes, to foster competition in the financial ecosystem by non-bank providers, including fintech firms, while also serving as a support to financial supervisors. This comprehensive approach can enhance the overall effectiveness of regulatory measures and promote a more dynamic and inclusive financial landscape. Our results are also informative for insiders in the fintech industry, including investors, fintech managers, and entrepreneurs, who wish to understand the dynamics of performance, funding, and capital structure as a result of new regulations. This knowledge can help fintech firms strategically navigate regulatory changes, optimize their operations, and enhance their competitive edge in the evolving financial landscape.

The paper is organized as follows. In Section 2, we review the literature on open banking and the fintech phenomenon. The identification strategy and the data employed to address our research question are discussed in Section 3. Section 4 details the methodology used for the empirical analysis. The main findings of the paper are presented in Section 5. In Section 6, we conduct additional analyses to examine how performance is affected and whether treated firms have improved their access to alternative market funding. Section 7 presents several robustness analyses. Finally, Section 8 concludes and discusses the implications of our findings.

2. Literature review

2.1. Data sharing and open banking

A growing body of research, extending beyond the banking sector, emphasizes the importance of data sharing and access for improving firms' efficiency and enabling the provision of diverse products and services. Access to data significantly influences firms' dynamics (Farboodi et al., 2019). Information sharing is particularly vital in the financial and banking industry due to its crucial role in credit allocation (Dell'Ariccia & Marquez, 2004), relationship lending (Brown & Zehnder, 2007), and risk management (Jappelli & Pagano, 2002).

In credit markets, data sharing has significant implications for all the actors involved. Nam's (2023) findings on accessing fintech credit suggest that data sharing can lead to more efficient credit allocation and reduced adverse selection. Access to banks' customer transaction data facilitates fintechs' screening of borrowers (He et al., 2023).

In particular, when consumers have control over their data and decide to share it, they can benefit by accessing loans at lower rates from non-traditional banks (Doerr et al., 2023). Goldstein et al. (2023) emphasize that data sharing enhances the welfare of financial services consumers, though it may reduce the resource allocation efficiency of the banking system. However, Parlour et al.'s (2022) model highlights the potential heterogeneous impact of data sharing on consumer welfare. For some consumers, data sharing could result in more choices and lower prices for financial products. Conversely, consumers who rely on traditional banks and lack technological sophistication may suffer as banks leverage their superior pricing power against them.

The emergent literature on open banking has highlighted its significant impact on the financial industry, particularly in terms of increasing competition, enhancing consumer and firm access to financial services, and promoting financial inclusion. He et al. (2023) examined the role of data access in open banking, demonstrating that these initiatives intensify competition within the financial industry. Similarly, Babina et al. (2024) and Polasik et al. (2020) found that the implementation of open banking initiatives has increased competition by facilitating fintech entry. However, the impact of open banking on competition may be influenced by bank maturity transformation (Goldstein et al., 2023).

In addition to increasing competition, the adoption of open banking initiatives has significant consequences for consumers and firms. The implementation of open banking improves conditions for consumers (He et al., 2023). Babina et al. (2024) obtained results suggesting that open banking enhances consumer outcomes by improving financial advice and access to credit products while allowing firms to establish new lending relationships with non-bank lenders. Moreover, the positive effects of open banking may be more pronounced for those who are financially excluded (Goldstein et al., 2023). Fang and Zhu (2023) showed that open banking regulations offer more choices and the promise of increased financial inclusion for consumers in emerging markets with a higher proportion of underbanked individuals. However, the effect of open banking can be negative for traditional financial institutions, as increased competition may erode their market shares. Using bank-level and individual-level data from BRICS countries, Fang and Zhu (2023) showed that the introduction of open banking significantly diminishes consumer loan lending by traditional

banks. Furthermore, Goldstein et al.'s (2023) theoretical model predicts that the shift from closed banking to open banking narrows bank spreads, impacting traditional banks' profitability.

Finally, consumer trust and privacy concerns in data sharing seem to play a crucial role in the decision to adopt open banking services. At the regulator level, consumer trust in data sharing with fintechs predicts open banking policy adoption (Babina et al., 2024). In this sense, Bijlsma et al. (2023) and Chan et al. (2022) show that consumer willingness to allow data sharing depends on the type of data user, financial incentives, and trust in the data user. There is evidence suggesting that open banking can have negative effects on traditional banks, fintechs, and other financial agents (Frei, 2023). A primary concern is the potential loss of market share for traditional banks as fintechs leverage open access to financial data, thus reducing banks' control over customer relationships and eroding their role as intermediaries, which may lead to lower profitability. Fintechs, on the other hand, may struggle with compliance and the significant investment needed to meet security standards, which can be particularly challenging for smaller firms. These findings highlight the importance of careful policy design and risk management to mitigate potential downsides of data sharing regulations.

2.2. The fintech phenomenon

The fintech phenomenon has grown significantly in recent years, prompting numerous studies analyzing its effects, as reviewed by Thakor (2020). For instance, Cornelli et al. (2023) discuss fintech's potential impact on the transformation of the financial industry. Chen et al. (2019) argue that fintech innovations provide substantial value to innovators, while Vučinić (2020) and Daud et al. (2022) discuss their implications for financial stability. In any case, the emergence of fintech firms as the initial competitors to traditional banks is not coincidental. A variety of economic, technological, and competitive factors underpin this phenomenon (Haddad & Hornuf, 2019; Laidroo & Avarmaa, 2020; Zavolokina et al., 2016). In particular, a key factor explaining the widespread proliferation of fintech firms in certain jurisdictions is the low degree of banking competition (Cornelli et al., 2023; Frost, 2020).

Several studies have focused on the impact of fintech firms on traditional financial institutions (e.g. Frost et al. (2019) and Feyen et al. (2021), among others). Typically, this impact manifests in a reduction in financial service costs, thereby improving consumer welfare (Berger, 2003; Fuster et al., 2019; Philippon, 2015), despite persistent gaps in access to fintech services, particularly among women (Chen et al, 2023). Irani et al. (2021) and

Buchak et al. (2018) report that the growth of loans issued by fintech firms is exerting pressure on the market share of traditional banks. For example, for the U.S. banking market, Cornaggia et al. (2018) document that a one-standard-deviation increase in fintech credit activity reduces the percentage of credit in the personal loan segment of banks by 1.2%. Similarly, Di Maggio and Yao (2021) conclude that fintech lenders are capturing market share from banks. Banks are affected by this change: Cuadros-Solas et al. (2024) show that the reduction in market power caused by fintech firms' provision of alternative credit affects bank stability.

Regarding fintech firm dynamics, studies such as Arner et al. (2016) and Zavolokina et al. (2016) explore the role of technological innovation in the growth and development of fintech companies. Similarly, Giaretta and Chesini (2021) examine the determinants of debt financing for fintechs in the UK from 2010 to 2015, concluding that regulatory status, asset structure, owner characteristics, and business activity significantly influence their primary funding sources. They find that unregulated fintechs are more likely to finance themselves with long-term debt. Generally, start-ups opt to borrow bank debt from informed banks to signal their quality, initiate their credit history, and build their reputations (Cole & Sokolyk, 2016; Milde & Riley, 1988). Compared to their unlevered peers, start-ups using debt are significantly more likely to survive (Cole & Sokolyk, 2018) and achieve faster growth in revenues and employment (Robb & Robinson, 2014). This effect is corroborated by Carbó-Valverde et al. (2022), who analyze fintechs' profits and survival rates, finding that large and solvent fintechs founded by single entrepreneurs are more likely to be profitable and to survive.

Another strand of literature relevant to our study is the effect of regulation on company performance. The regulatory environment for fintechs is still evolving (Bromberg et al., 2017), making it essential to understand the implications of different policies on this sector. Possibly the most relevant policy in this regard is that regarding open banking. However, the effects on fintech firms of open banking regulations such as Europe's PSD2 remain understudied. To the best of our knowledge, only Cornelli et al. (2024) provide evidence in this respect, showing that firms in the UK entering the regulatory sandbox experience a significant 15% increase in capital raised post-entry. Therefore, our work complements prior studies and contributes new evidence, aiming to assist policymakers in making informed decisions when regulating fintech activities.

3. Identification strategy

3.1. The Second Payment Services Directive (PSD2)

Open banking enables the secure sharing of customer financial data between banks and authorized third-party providers (TPPs). Specifically, with open banking, customers are empowered to grant permission for their banking information, including transaction history, account balances, and payment history, to be accessed by other authorized financial service providers. Previous studies (Dratva, 2020; He et al., 2023; Polasik et al., 2020) and regulators[2] have underlined that open banking regulations could significantly impact the competitive landscape of the financial industry. By providing shared access to customer data primarily for payment purposes, open banking fosters competition between traditional banks and emerging fintech challengers.

Countries worldwide are adopting open banking to drive innovation, enhance competition, and empower customers within their financial sectors.[3] While the UK[4] pioneered the first open banking regulation, the EU's implementation of an open banking framework is particularly notable. This framework was established with the approval of the Second Payment Services Directive (PSD2).[5] While PSD2 was enacted in 2015, its key provisions affecting third-party providers (TPPs), specifically payment initiation service providers (PISPs) and account information service providers (AISPs), took effect on January 13, 2018. This date marked their formal recognition under EU regulations, granting TPPs the ability to access customer banking data and initiate payments. Additionally, from 2018 onwards, PSD2 introduced broad mandates for enhanced security measures, including strong customer authentication (SCA). These measures were further detailed and progressively enforced with the introduction of the Regulatory Technical Standards (RTS), beginning on September 14, 2019. In particular, PSD2 implemented open banking in Europe by allowing TPPs to initiate payments directly from the customer's bank account on their behalf (PISP)

[2] The European regulation on open banking underlines that the main objectives are "to contribute to a more integrated and efficient European payments market and to further level the playing field for payment service providers by including new players." Accessible at https://www.ecb.europa.eu/paym/intro/mip-online/2018/html/1803_revisedpsd.en.html

[3] Babina et al. (2024) report that as of October 2021, 49 jurisdictions (e.g., Australia, Canada, Japan, Singapore, South Korea, and Mexico) had adopted key open banking policies. This number has been steadily increasing. According to openbankingtracker.com, by the end of the third quarter of 2024, more than 70 jurisdictions had implemented or were actively reviewing open banking regulations. This total exceeds 100 when considering jurisdictions in which open banking regulations are under discussion.

[4] The UK Open Banking initiative was mandated by the financial regulator (Competition and Markets Authority (CMA)) in 2016 following an extensive investigation into the retail banking sector to increase competition and innovation in the banking industry. To facilitate this, the Open Banking Implementation Entity (OBIE) was created.

[5] The full disclosure of the EU Directive can be accessed at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32015L2366

and requires banks to provide authorized TPPs with access to their customers' account information (AISP) through application programming interfaces (APIs)[6].

The PSD2 framework in Europe stands out from other jurisdictions' open banking initiatives due to three main factors. Firstly, PSD2 is a regulatory-driven initiative rather than a market-driven one.[7] Unlike in countries such as the US, India, and Japan, where open banking is driven largely by market forces, PSD2 establishes a legal mandate for financial institutions to provide authorized third-party providers with standardized and secure access to customer data with the users' consent. Consequently, PSD2 simplifies data access for TTPs without the need for lengthy negotiations with each financial institution, thus also increasing customers' trust.

Secondly, PSD2 is specifically focused on payments. It mandates access to payment account data and services to enhance competition and innovation within the payments industry. This focus contrasts with broader frameworks such as Australia's Consumer Data Right (CDR), which encompasses multiple sectors beyond banking. PSD2's primary focus on the payments sector is clear from its denomination and scope, as stated in Article 2.1: "This Directive applies to payment services provided within the Union." Therefore, PSD2 aims to increase competition and promote the growth and strengthening of the payments sector.[8] To achieve this, the regulation places special emphasis on introducing open banking services by allowing third-party providers (TPPs) to access payment account information and initiate payments. Its main objective is to foster the development of new payment solutions and technologies. By opening up access to payment data, PSD2 encourages new market entrants, including regulated fintech companies, which can introduce more competitive and user-friendly payment services.

Lastly, and closely related to the previous factor, PSD2 implements measures specifically designed to enhance the convenience and security of digital payments. These measures include the introduction of strong customer authentication (SCA) and regulatory

[6] In Spain, APIs are predominantly offered by a single provider, Redsys. Redsys is a payment infrastructure and technology company that provides the necessary framework for banks and third-party providers (TPPs) to comply with open banking regulations, particularly those outlined in the European Union's PSD2 directive. By serving as the main API provider in Spain, Redsys facilitates standardized access to banking data and services, ensuring consistency and interoperability across the financial ecosystem. This standardization can streamline adoption and integration processes for banks and TPPs, although it may also introduce limitations in terms of flexibility

[7] In a market-driven approach, third-party providers (TPPs) and banks often engage in lengthy negotiations regarding data access, with the scope of data varying in each case. Although the government may encourage these negotiations, it does not interfere with or mandate such access.

[8] Outside of the scope of this analysis is the impact of the Financial Data Access (FIDA) regulation, which was enacted in June 2023. It aimed to enhance the framework for open banking, extending access to a broader range of financial data beyond payments alone.

technical standards (RTS) to ensure secure and efficient electronic transactions. SCA requires multi-factor authentication, which significantly reduces the risk of fraud and unauthorized transactions, making electronic payments more secure. The RTS provides detailed requirements for the implementation of SCA and secure communication between financial institutions and TPPs, as well as between the latter and their respective clients. The RTS ensures that all parties involved in the payment process adhere to the highest security standards, creating a consistent and robust framework for electronic transactions. These security measures provide a level of detail and enforceability that sets PSD2 apart from regulations with less stringent security mandates that have been enacted in other jurisdictions. For example, while other countries may encourage secure practices, PSD2 makes such practices a legal requirement, ensuring uniform compliance and significantly enhancing the overall security of the digital payment ecosystem. This approach is relevant because, by mandating such comprehensive security protocols, PSD2 bolsters consumer trust in digital payments. When consumers are confident that their transactions are secure, they are more likely to use electronic payment methods, which in turn fosters a safer and more efficient digital payment environment.

Overall, the implementation of PSD2 creates an intertwined policy intervention by allowing third-party providers (TPPs) to access banks' data while simultaneously improving the convenience and security of digital payments through the strong customer authentication (SCA) and Regulatory Technical Standards (RTS) measures. As such, its implementation provides a unique research setting to examine the impact of this open banking initiative on the dynamics of new market players such as fintech firms. Furthermore, as PSD2 is a payments-focused open banking framework, it allows us to identify the specific types of fintech firms that are particularly affected by its implementation.

3.2. Open banking and fintech: Payments-focused fintech

As prior studies and the regulation acknowledge, the implementation of an open banking framework significantly impacts potential TTPs, especially fintech firms. He et al. (2023) emphasize that open banking significantly enhances the competitiveness of fintech companies as challengers in the industry. With access to detailed financial data, fintech firms can develop and offer innovative financial products. This level of access allows fintech firms to compete more effectively with traditional financial institutions. Furthermore, the superior technological capabilities of fintech firms compared to other TTPs (Fuster et al., 2019; Gambacorta et al., 2024; Ghosh et al., 2021) enable TPPs to integrate with open banking systems more efficiently. This technological advantage positions fintech firms to benefit

more from the open banking framework than other TTPs, allowing them to leverage data access for rapid innovation and enhanced service delivery.

Due to its key features, PSD2 directly and specifically impacts certain fintech firms, namely those dedicated to payments (*Paytech fintech*). Moreover, the increased security of digital payments achieved through the implementation of SCA and RTS measures affects Paytech firms distinctively. These measures reduce operational risk when consumers make payments (e.g., by eliminating the need to enter lengthy credit or debit card information, as TPPs are used instead) and enhance the user experience (e.g., by allowing customers to stay logged in to systems for up to 90 days, reducing the friction involved in the login procedure).

Additionally, payments-focused fintech firms benefit from this regulation as they can leverage access to customer account data to offer alternative payment options, potentially undercutting traditional banking services such as online payments, peer-to-peer transfers, and mobile wallets. Moreover, PSD2 enables Paytech fintechs to create seamless payment experiences by integrating banking services directly into their applications. The implementation of PSD2 enables payments-focused fintech companies, unlike other types of fintech companies, such as those involved in insurance, investments, and financial infrastructure, to compete with traditional banks and gain market share within the highly competitive payment ecosystem. In practice, PSD2 reduces barriers to entry for these payments-focused fintechs, which is a crucial aspect in understanding their development. The existing literature highlights that broadening the regulatory environment promotes the growth of fintech companies (Claessens, Frost, et al., 2018; Frost, 2020) .

In a similar vein, previous studies support that PSD2 has impacted the payments spectrum of the fintech ecosystem specifically. Polasik et al. (2020) document this regulation's effect on the development of the payments fintech sector in terms of promoting entrepreneurship. Moreover, Bijlsma et al. (2023) find that following the implementation of open banking, payment fintech firms could offer more favorable financial conditions compared to traditional banks. On the theoretical front, Parlour et al. (2022) focus on the impact of open banking on fintechs specializing in payment services. These authors show that open banking leads to increased competition from Paytech fintech firms, which affects the pricing of payment services offered by banks.

Empirically, the implementation of PSD2 as an open banking framework provides an ideal laboratory to answer our research question. Given its nature as a regulatory-driven initiative, where data sharing is compulsory rather than voluntary, its focus on payments-related services, and its enhancement of digital payment safety, it directly affects Paytech

firms within the fintech ecosystem. Additionally, its clearly defined timeline, with its implementation at the beginning of 2018, further supports its suitability for our analysis.

We focus our analysis on three main dimensions: performance, funding structure, and real economic outcomes. Open banking enables Paytech fintech firms to access detailed financial data, allowing them to offer personalized and innovative payment and financial products while reinforcing the security of digital payments. This enhances their competitiveness, potentially leading to improved performance metrics such as higher customer acquisition rates, increased transaction volumes, and greater profitability. Additionally, with the implementation of PSD2, fintech firms and particularly Paytech firms may have experienced a shift in their funding structure. Access to customer data and the ability to provide enhanced payment services may make these firms more attractive to investors, which could result in diversification of their funding structure. Finally, if open banking makes Paytech fintech firms more competitive and attractive to investors, it may influence their investment strategies, demand for labor, and productivity. Enhanced access to funding may lead to increased investments in tangible and intangible assets, higher labor intensity due to the need for skilled professionals, and improved productivity through the adoption of advanced technologies and efficient data management.

3.3. Data and sample composition

3.3.1. Microdata

To answer our research question, we build a fintech-level dataset representative of the Spanish fintech ecosystem by combining various sources of information. Spain serves as a unique laboratory for exploring the impact of open banking on the fintech sector. Within the broader European context, the Spanish fintech ecosystem is recognized as a robust and dynamic sector and plays a key role in the region's fintech landscape. According to European fintech associations, Spain boasts one of the highest ratios of fintech companies per capita in Europe, with approximately one fintech firm for every 67,811 inhabitants.[9] As per the FinTech Radar developed by the Bank of Spain, there were 794 fintech firms with unique fiscal identifiers as of January 2024, though some firms may operate under multiple brand names. The vibrancy of the Spanish fintech ecosystem is underscored by its ability to attract investment. FinTech Global Research reports that from 2018 to 2023, the total investment in Spanish fintech firms exceeded €2.5 billion.

[9] https://fintechmagazine.com/top10/top-10-european-fintech-associations-and-trade-bodies. FinTech Magazine. 23 October 2023.

Spain, like many other countries, does not maintain an official register of fintech companies, as some of these companies' activities do not require registration with a supervisory authority. In this context, in 2019, the Financial Innovation and Statistics Departments of the Bank of Spain began compiling a census of fintech companies operating in the Spanish market using public information obtained from official registers and business associations and private information obtained from consulting firms. Alongside data from these reliable sources, expert judgment was used to determine whether a firm's activity fits the Financial Stability Board's (FSB) definition of fintech.[10] This census of fintech companies is named the Fintech Radar. The details regarding the methodology followed and the procedure can be found in Sánchez and Quintanero (2022) and Quintanero et al. (2020). We crosschecked the list of fintech firms reported by the Fintech Radar with a subsample of the Central Balance Sheet Data Office at the Bank of Spain, known as "Fintech non-bank entities" (FIN). Although the FIN data is not as rich and frequently updated as the Fintech Radar, this crosscheck allows us to ensure the consistency of our sample of fintech firms. As a result, we identified 794 Spanish fintech firms.[11]

To match the fintech firms with their accounting data, we merged the fintech census with the Bank of Spain Central Balance Sheet Data (CBI). This database, collected by the Central Balance Sheet Data Office (*Central de Balances*), contains individual balance-sheet information for non-financial individual firms in Spain.[12] The data is sourced from the mandatory annual account deposits in the Mercantile Registries, based on an agreement between the Bank of Spain and the Spanish Association of Mercantile and Property Registrars (CORPME). We accessed this dataset through the Bank of Spain Data Laboratory (BELab), an initiative launched in 2019 to provide researchers with high-quality microdata in a controlled environment that ensures data confidentiality.

By matching the list of fintech firms from the Fintech Radar with the microdata available in the CBI, we build a rich and granular panel dataset of Spanish fintech firms,

[10] The FSB defines fintech as "technology-enabled innovation in financial services that could result in new business models, applications, processes or products with an associated material effect on the provision of financial services. FinTech firms is used here to describe firms whose business model focuses on these innovations."
https://www.fsb.org/wp-content/uploads/P140219.pdf

[11] To ensure that our sample of firms consists of fintech firms, in Section 7.2, we conduct a subsample analysis using those fintech firms classified as technological or financial firms according to their CNAE (NACE) code. This complementary analysis helps us verify that the firms included in our analysis genuinely belong to the fintech sector and thus enhances the accuracy and relevance of our results.

[12] CBI has provided annual balance sheet information of Spanish non-financial individual enterprises since 1995. This data is designed to present a comprehensive picture of the economic and financial situation of Spanish firms by including information on their assets, liabilities, revenues, and expenses, as well as their profitability, solvency, and liquidity positions.
https://www.bde.es/wbe/en/areas-actuacion/central-balances/

including detailed balance sheet information. The final sample consists of 427 fintech companies with complete data from the CBI.

3.3.2. Sample representativeness

To ensure that our sample of FinTech firms—for which we have microdata—is representative of the total population of FinTech firms in the FinTech Radar, we compared the distribution of FinTech firms by business model in our sample to that of the population. Four main categories are considered in this analysis: lending & crowdfunding, payment, investment, and other. **Table 1** provides a breakdown of FinTech firms across these categories. As shown, our sample closely reflects the total population of Spanish FinTech firms identified in the FinTech Radar, capturing a significant proportion of each category. This analysis confirms the representativeness of our sample.

[INSERT TABLE 1]

4. Empirical analysis and methodology

4.1. Difference-in-differences (DiD) analysis

To address our research question, we employ a difference-in-differences (DiD) specification. This method is effective in isolating the effects of the PSD2 directive on fintech companies by comparing changes in economic outcomes over time between treated companies (those affected by the regulation) and a control group (those not affected). This approach enables us to compare a treatment group (*Paytech fintech*) and a control group (*Non-paytech fintech*) before and after the implementation of PSD2. In particular, this analysis enables us to determine whether the regulatory initiative's objectives – namely, increasing competition and fostering growth in the payments sector – are being achieved.

The unique characteristics of PSD2 allow us to identify payment-focused fintech firms (*Paytech fintech*) as the treated group under the open banking framework, while the remaining fintech firms serve as the control group. To determine which of the 427 fintech firms with available microdata can be classified as *PayTech fintech*, we employ a dual strategy. In any case, when identifying PayTech fintech firms, we must consider two main criteria, as discussed above. First, some fintech firms can be easily identified as PayTech because they hold a payment license and are registered to operate as EMIs, AISPs, or ASPSPs. However, under the PSD2 framework, there may also be fintech firms without a license that are impacted by this regulation if their core business is affected by the adoption of SCA and RTS measures. This dual impact justifies the adoption of a dual strategy for identifying PayTech firms. Then, first, we utilize the qualitative information from the FinTech Radar, including

descriptions of activities, related firms, technologies used, relevant facts, and brand names, to understand the business activities of each fintech firm. Table A2 details all the sources employed by the FinTech Radar and the information provided. The FinTech Radar provides a primary classification of fintech firms based on their business model. Then, we apply expert judgment to examine each fintech firm individually. This evaluation determines whether the firm's core business is impacted by the adoption of SCA and RTS measures or if they can access bank data to initiate payments as third-party providers (TPPs). Fintech firms that meet this criterion are classified as *Paytech fintech* (treated), while the remaining firms are classified as *Non-Paytech fintech* (control). For consistency, we perform a final check to ensure that all fintech firms holding a payment license to operate as EMIs, AISPs, or ASPSPs are included in the treated group. This verification confirms the validity of our dual strategy for identifying PayTech fintech firms.

Upon careful consideration, 49 of the 427 fintechs are identified as being impacted by the PSD2 regulation. This group includes nine TPPs directly subject to the regulation, comprising three account information service providers (AISPs) and six payment initiation service providers (PISPs). Additionally, we categorized 40 fintechs focused on payment services, such as electronic money institutions, e-wallets, payment gateways, and mobile payments, as affected. The remaining fintech firms, which are primarily focused on investments, asset management, financial infrastructure, equity finance, and other sectors, are included in the control group.

Finally, to ensure a homogeneous treated group, we exclude lending fintech firms that could be indirectly affected by the open banking framework. Specifically, we exclude 21 lending fintech firms from the analysis: 16 dedicated to micro-lending and five mortgage intermediators. Although these firms might utilize AISP services, their business nature is distinct from payment services and aligns more closely with credit institutions, which are not covered in our microdata. Furthermore, while these fintech firms could benefit from open banking by accessing information disclosed by account aggregators,[13] they typically do not have direct access to customer information because they do not offer payment services. Additionally, their minor representation among lending fintechs leads us to exclude them from our sample, as including them in the control group could introduce bias. In this sense, the impact of open banking on credit and lending institutions is beyond the scope of our analysis[14].

[13] Account aggregators can provide lending fintechs with a holistic view of a borrower's financial situation by consolidating data from multiple accounts and financial institutions.

[14] For robustness purposes, we re-ran our main regressions including these lending firms. Our results, available upon request, remained qualitatively unchanged

Consequently, our final sample consists of 406 fintech firms operating in Spain from 2014 to 2022, with 49 classified as treated (Paytech) and 357 used as controls (Non-Paytech). **Table 2** displays the number of treated and control firms per year, with the percentage of treated firms remaining constant at around 11%. The drop in the number of firms in 2022 is due to the CBI not being fully updated.[15]

[INSERT TABLE 2]

To conduct our empirical analysis and to ensure a balanced time period with an equal number of years before and after the implementation of PSD2, we focus on the period from 2014 to 2022. Following standard practice in the literature, we use a two-way fixed effects estimator that includes firm and year fixed effects, as shown in equation (1):

$$y_{i,t} = \beta_0 + \beta_1 Post\_PSD2_{i,t}\ x\ Payment\ FinTech_{i,t} + \beta_2 X_{i,t-1} + \delta_t + \varepsilon_i + u_{i,t} \quad (1)$$

Where $y_{i,t}$ represents the dependent variable for firm *i* in time period *t*. As indicated before, we focus our analysis on three sets of dependent variables. First, we consider measures of firms' performance: return on assets (ROA) and return on equity (ROE). As a robustness check, we also examine alternative performance measures in Section 7.1.

Second, we analyze the impact of open banking on fintech firms' funding by examining the ratio of bank debt (non-bank debt) to total liabilities ($Bank\ debt\_liab_{it}$ and $Nonbank\ debt\_liab_{it}$) and to total assets ($Bank\ debt\_assets_{it}$ and $Nonbank\ debt\_assets_{it}$). By scaling our measures by assets and liabilities, we ensure that the results are not driven by substantial changes in the firms' balance sheet structures. Moreover, we distinguish between long-term and short-term debt. This additional distinction allows us to analyze how different types of debt financing are affected by the PSD2 regulation and offer a more comprehensive understanding of its impact on fintech firms. To provide additional insight into the impact of PSD2 on fintech funding, we also compute the $Cost\ of\ funding_{it}$ – defined as the ratio of interest on borrowed funds to total debt – and $Interest\ burden_{it}$, which is calculated as the ratio of interest on borrowed funds to the sum of gross operating profits and financial revenues.

Finally, we also consider various economic outcomes related to firms' investments ($Tangible\ assets_{it}, Intangible\ assets_{it}\ and\ Financial\ investments_{it}$), liquidity ($Current\ assets_{it}$), labor intensity and cost of labor ($Hiring\ Employees_{it}$,

[15] For robustness purposes, we excluded the year 2022 from our analysis, and the results hold. These results are available upon request.

$Employees\ to\ total\ assets_{it}$ and $Cost\ of\ labor_{it}$), and firms' productivity ($Productivity_{it}$). This comprehensive approach allows us to capture a wide range of potential impacts of the PSD2 regulation on fintech firms. All the variables are defined in Table A.1.

$X_{i,t-1}$ includes a set of controls commonly used in the literature. All the independent financial variables are lagged by one period to avoid endogeneity concerns due to a potential two-way relationship between the independent and dependent variables. Fintech size is measured using the natural logarithm of total assets. Asset structure is computed as the ratio of current assets to total assets. Solvency is measured as the ratio of total equity to total assets. Leverage is defined as the ratio of total liabilities to total equity. We also consider a measure of fintech efficiency, using the ratio of operating revenue to the total sum of equity and noncurrent liabilities. Finally, we consider the age of the fintech firm as the number of years since the firm's creation. All the accounting variables are winsorized to the minimum and maximum values at the 1st and 99th percentiles, respectively, to avoid biases arising from outliers or potential misreporting of accounting information.

$Post\_PSD2_{i,t}\ x\ Payment\ FinTech_{i,t}$ is our variable of interest. It is the interaction of $Payment\ FinTech_{i,t}$, a dummy that takes the value 1 if the fintech is treated and 0 otherwise, and $Post\_PSD2_{i,t}$, a dummy that takes the value 1 after 2018 and 0 before. This interaction is therefore our DiD term, and the estimation of β_1 will capture the causal effect of treatment on the outcome. ε_i represents the firm-specific fixed effects, which are allowed to vary across firms but are constant over time. δ_t represents the year-specific fixed effects. In particular, the year fixed effects difference away trends that affect treatment and control group fintech firms. Finally, $u_{i,t}$ is the time-specific error term. This model allows the intercept to vary across firms, and it controls for all time-invariant heterogeneity that could affect the dependent variable, including the fintech status of the company. Finally, as is also standard in the literature, standard errors are clustered at the firm level.

Table 3 reports the main statistics of the key dependent and control variables for treated and control firms.[16]

[INSERT TABLE 3]

4.2. Parallel trends

To establish the validity of the DiD analysis, it is crucial to ensure that both the treated group and the control group exhibit similar trends in outcomes (such as profitability

[16] See the appendix for the full definition of the variables.

and bank lending) prior to the implementation of PSD2. Only by establishing this assumption of parallel trends between the two groups can we attribute differences in outcomes to the impact of PSD2. Following the spirit of Lemmon and Roberts (2010) and Calderon and Schaeck (2016), and as is standard in the DiD literature, we test the parallel trends assumption by examining whether changes in the outcome variables are similar across the two groups of countries before the implementation of the treatment. **Table 4** presents the *t*-test results for the differences in means between the treatment and control groups over the four years prior to the implementation of PSD2 in terms of performance (ROA and ROE), funding (bank debt), and employment.[17] All *t*-test results are insignificant. Thus, the parallel trends assumption holds. This result indicates that, in the absence of treatment, changes in the outcome variables are similar for the two groups of fintech firms.

[INSERT TABLE 4]

5. Baseline results

5.1. Performance

Table 5 presents the results of our baseline regression [1] for our performance measures. Focusing on ROA, the positive and statistically significant coefficient of the DiD term in Column 1 reveals that Paytech fintech (treated) firms performed better than control firms after the implementation of PSD2. On average, treated firms exhibit a 23% higher ROA after PSD2 compared to control fintech firms. Moreover, as Column 3 shows, this result is not driven by a large reduction in firm assets, which could artificially inflate ROA even if profits remained unchanged. Since the result for asset growth is not significant, this does not seem to be the case. Paytech firms exhibit a higher ROA because they are generating larger profits. Overall, this finding regarding firm performance suggests that fintech firms that began offering safer and more streamlined payment solutions with the implementation of the open banking framework benefited by achieving higher profits. The lower barriers of entry to compete in the financial industry led those fintechs to be more profitable. In a sense, this result aligns with the expected outcomes of the open banking regulation. The positive causal impact of PSD2 on ROA indicates that, after the implementation of PSD2, payment fintechs increased their access to customer data and payment systems, fostering innovation and competition in the sector. As PSD2 facilitated payment-focused fintech firms' offering of streamlined payment solutions, it may have been easier for these companies to gain market share in the payments sector, thus boosting their returns.

[17] This test was also performed on the other outcome variables used in the paper. The results confirm that, for these variables, the parallel trends assumption holds. The results, which are not reported here due to space constraints, are available upon request.

However, as Column 2 of **Table 5** shows, we do not find an effect of PSD2 implementation on ROE. This finding should be interpreted together with the results regarding the growth of firms' capital. Column 4 of **Table 5** shows that treated fintech firms experienced a larger growth in equity compared to the control group. This suggests that while Paytech firms are generating higher profits, they are also significantly increasing their equity base. Consequently, any gains in profitability are offset by increases in equity, leaving ROE unchanged. This expansion in equity could be due to reinvested earnings or additional funding, which dilutes ROE despite higher profitability. In fact, PISP companies were required by regulation to maintain a minimum of their own funds once PSD2 came into effect. Moreover, the growth in equity could also indicate that Paytech firms are not only becoming more profitable but are also attracting more equity funding, which is essential for supporting growth and innovation.

For robustness purposes, in Section 7.1, we employ alternative performance metrics as dependent variables, such as operating ROA (EBIT to total assets), EBITDA ROA, and ordinary net profits to total assets, as well as a dummy variable that takes the value 1 if profits were higher than the average profits in the three years prior. The results on performance remain qualitatively similar.

[INSERT TABLE 5]

To gain deeper insight into the positive and significant effects of open banking on the performance of Paytech fintech firms, we investigate whether the characteristics of these firms influence PSD2's impact on their performance by extending the baseline regression. To explore potential heterogeneous effects on performance, we interact the DiD term with variables representing key characteristics of fintech firms: size (Column 1), solvency (Column 2), indebtedness (Column 3), and age (Column 4). **Table 6** presents the results of this heterogeneity analysis, focusing on the additional term in regression (1), $Post\_PSD2_{i,t}\ x\ Payment\ FinTech_{i,t}\ x\ Variable$, where "variable" denotes the specific fintech-level characteristic considered. The coefficient of this term reflects whether the magnitude of the effect varies based on the fintech firm's characteristics. As can be seen in **Table 6,** the positive impact on performance following the adoption of an open banking framework is less pronounced for larger, more solvent (highly capitalized), and more indebted (highly leveraged) entities. However, we do not find a differential effect based on the age of the fintech firm. These results suggest that the benefits of open banking may be more significant for smaller, less capitalized, and less leveraged fintech firms, potentially due to their greater flexibility and capacity to innovate. Larger firms and those with higher

solvency and indebtedness may face structural or strategic constraints that limit the positive impacts of PSD2 on their performance.

[INSERT TABLE 6]

5.2. Funding

To examine the effect on funding, we use a sequential approach. Firstly, we explore the impact of access to funding by focusing on fintech firms' leverage on bank and non-bank debt (e.g., trade debt, bonds, private equity debt, crowdfunding debt and/or government loans). In doing so, we employ, as dependent variables, the ratios of bank debt (non-bank debt) to total liabilities ($Bank\ debt\_liab_{it}$ and $Nonbank\ debt\_liab_{it}$). Using these ratios allows us to shed light on firms' reliance on different types of funding and highlight the proportion of their liabilities that are financed through bank versus non-bank sources (i.e., the diversification of firms' debt structure). However, as mentioned above, we also scale the volume of bank debt and non-bank debt by total assets ($Bank\ debt\_assets_{it}$ and $Nonbank\ debt\_assets_{it}$). This scaling ensures that our findings are not driven by substantial changes in the firms' balance sheet structures.

The negative and statistically significant coefficient of the DiD term in Columns 1 and 2 of **Table 7** reveals that after the implementation of PSD2, Paytech firms rely less on bank debt compared to other fintech firms (control). On average, post-PSD2-treated firms show an 11% reduction in bank debt compared to the control group. However, as shown in Columns 3 and 4, the negative effect on bank debt is not offset by an increase in non-bank debt. The coefficients on non-bank debt are positive but not statistically significant. Taken together, these findings suggest a shift towards alternative financing strategies, such as internal funding or equity financing, rather than increased reliance on non-bank debt. This potential substitution of bank debt with equity funding aligns with previous findings indicating higher growth in equity for treated firms compared to control firms.

[INSERT TABLE 7]

After examining access to bank and non-bank funding, we also explore the maturity of the debt and the cost of funding (**Table 8**). To explore whether the implementation of PSD2 has affected the maturity structure of fintechs' debt, we distinguish between long-term and short-term debt.[18] As can be seen in Table 8, the effect on bank debt seems to be driven

[18] Due to space constraints, we focus only on the ratio of debt (both long-term and short-term) to total liabilities. The results using total assets as the denominator are similar and available upon request.

by Paytech fintechs (treated) relying less on long-term bank debt after the implementation of PSD2 compared to other fintechs (control). On average, treated firms exhibit an 8% decrease in long-term bank debt. There also seems to be a reduction in short-term bank debt, but it is not significant at 10% (Column 2). Columns 3 and 4 of **Table 8** reveal that PSD2's impact on the maturity structure of non-bank debt is statistically insignificant. The decline in long-term bank debt following PSD2 does not appear to be compensated for by an increase in short-term debt, which could again indicate that Paytech firms might be opting for other forms of long-term financing, such as equity funding. Furthermore, if the adoption of the open banking framework has made Paytech firms more profitable (as shown in Section 5.1), investors may be more attracted to investing in these firms due to the potential for higher returns. In this context, following the implementation of PSD2, treated firms may have become more attractive to alternative funding providers (e.g., venture capitalists, angel investors, and private equity firms) who anticipate higher returns on their investments. Additionally, licensed Paytech fintechs – PISP and AISP – might be seeking to raise more capital to meet the regulatory capital requirement for the license.

[INSERT TABLE 8]

We also examine the impact of the open banking framework on the cost of funding and interest burden. Column 5 of **Table 8** shows that the cost of funding does not seem to be affected by the PSD2, with Paytech firms experiencing neither an increase nor a decrease in the financial costs (interest paid) from their debt compared to the control group. However, there is a decline in the interest burden in the treated fintech firms (Column 6). Since the interest burden metric evaluates the proportion of a firm's earnings used to cover interest expenses, this decline could indicate that higher profits are allowing these firms to cover their interest expenses with a smaller portion of their earnings. This is particularly evident as the treated firms' cost of funding remains unchanged (Column 5 of **Table 8**), while their earnings have increased (Section 5.1). Consequently, the reduction in interest burden suggests that after the implementation of PSD2, Paytech fintech firms exhibit better financial health and reduced financial risk compared to other fintech firms. This final result confirms the positive effect of the implementation of an open banking regulation in terms of financial health for fintech firms offering payment-related services.

Finally, as **Table 9** shows that bank debt is reduced for the treated fintech firms, we focus on this aspect to check for potential heterogeneities in the decline of bank debt, following an approach similar to that used in the performance heterogeneity analysis. **Table 9** shows that, unlike what was observed in the performance analysis, none of the coefficients

associated with these variables are significant. This means that the post-PSD2 effect on bank debt in the treated firms is homogeneous by size, solvency, indebtedness, and age.

[INSERT TABLE 9]

5.3. Real economic outcomes

Having analyzed the impact of PSD2 on the performance and funding structure of fintech firms, we now examine how the adoption of open banking affects firms' investments, labor intensity, and productivity.

Table 10 shows that Paytech fintech firms (treated) invest less in intangibles (Column 2) and financial assets (Column 3) after the implementation of PSD2 compared to the other fintech firms (control). The reduced investment in intangible and financial assets suggests that Paytech fintech firms may be prioritizing liquidity over long-term investments. This result aligns with the larger increase in the share of current (more liquid) assets shown in Column 4. Overall, this finding suggests that the treated fintech firms are not using their profits to make large investments but are instead engaging in "liquidity hoarding" behavior. It appears that the adoption of open banking through PSD2 leads Paytech fintech firms to prioritize liquidity and operational flexibility over long-term investments.

[INSERT TABLE 10]

Regarding the impact on labor demand, **Table 11** shows that Paytech fintech firms have reduced their labor intensity compared to the other fintech firms. They are less likely to hire new workers (Column 1 of **Table 11**) and exhibit a lower ratio of employees to total assets (Column 2 of **Table 11**). However, they have increased their labor costs (Column 3 of **Table 11**). This finding suggests a shift from low-skill to high-skill labor, with the latter being inherently more expensive. While Paytech firms hire fewer employees overall, they invest more in skilled labor, leading to higher labor costs. This shift could be due to the need for specialized skills in technology development, data analysis, and regulatory compliance. Furthermore, these Paytech fintech firms exhibit higher productivity after the implementation of PSD2 compared to other fintech firms (Column 4 of **Table 11**). The higher productivity also reflects the effective utilization of specialized, highly skilled labor, which allows these firms to achieve more output with fewer employees.

[INSERT TABLE 11]

6. Performance channel and alternative market funding

6.1. Performance channel

After showing that the adoption of PSD2 in Europe has led Paytech firms to improve their performance, we examine the reasons for this performance increase. There are two main channels by which firms could become more profitable: an income improvement channel and a cost reduction channel. The income improvement channel focuses on increasing sales and revenue, enabling firms to generate additional profits, while the cost reduction channel focuses on improving cost efficiency, enabling firms to maintain their income sources while cutting operational expenses.

In general, the adoption of open banking through PSD2 could have led Paytech firms to become more profitable by leveraging both the income improvement and cost reduction channels. Paytech fintech firms could have increased their income through personalized services, expanded market reach, and innovative product offerings. These enhancements could be the result of accessing detailed financial data of bank customers, as mandated by PSD2, and the reinforcement of digital payment security through the implementation of the strong customer authentication (SCA) and Regulatory Technical Standards (RTS) measures. Moreover, Paytech fintech firms could have improved their performance by becoming more operationally efficient and productive. As both channels could be driving the improved performance, we examine whether one of them is more prevalent than the other, or if both are occurring simultaneously. By analyzing the relative contributions of income improvement and cost reduction, we can better understand the primary drivers of profitability for Paytech fintech firms under the open banking framework of PSD2.

To test the income improvement channel, our main dependent variable is the growth of output value, which is measured as the annual growth rate of total sales and changes in stock. To test the cost reduction channel, we use the growth of operating costs as our main dependent variable, measured as the annual growth rate of total inputs and personnel expenses. **Table 12** presents the results. The sign of the coefficients aligns with our expectations, as it is positive for the income improvement channel and negative for the cost reduction channel. However, only the effect of the income improvement channel is statistically significant, indicating that it is this channel that drives the positive effect on performance.

[INSERT TABLE 12]

6.2. Alternative market funding

The results presented in Section 5.2 suggest that the implementation of the open banking framework in Europe has led to a shift towards alternative financing strategies, such as equity financing. This shift is driven by a reduction in long-term bank debt that is not offset by an increase in non-bank debt. The potential substitution of bank debt with equity funding aligns with increased investor interest in Paytech fintech firms, which exhibit higher returns than control firms (as shown in Section 5.1). Additionally, treated firms show higher growth in equity compared to control firms.

Anecdotal evidence from the media supports the notion that the adoption of open banking has attracted significant investment to fintech firms focused on payments. A 2023 article published by TechCrunch,[19] a specialized global online newspaper focused on high-tech and startup companies, titled "*Open banking led to a fintech boom — as Brite raises $60M, account-to-account payment grows*" discusses how open banking has spurred the fintech boom, particularly in the EU, by promoting account-to-account (A2A) payments: "The move toward open banking payments, especially in the EU, effectively kicked off the fintech boom. [. . .] There's been a growing number of startups now taking advantage of this account-to-account (A2A) payments boom." Moreover, according to FinTech Global Research, from 2019 to 2023, European Paytech fintech firms raised €23.64 billion, making them the most significant subsector within the fintech ecosystem. This trend is also observed in other jurisdictions that have implemented open banking. A 2023 article published by Financial Magnates, titled "The adoption of open banking and its impact on the payments industry in the United Kingdom," suggests similar outcomes in the UK.[20]

This section empirically examines the extent to which the implementation of open banking regulations has fostered access to alternative market funding for Paytech firms. Specifically, we explore the effect of PSD2 on the ability of treated firms to obtain alternative equity funding, such as seed capital, venture capital, and Series A funding. This is relevant because providing empirical evidence on access to alternative market funding will clarify its effects on performance and the broader impact of open banking regulations.

To achieve these aims, we matched our sample (CBI + FinTech Radar) with the information on all the equity funding rounds in which Spanish fintechs were involved. The

[19] Techcrunch. "Open banking led to a fintech boom — as Brite raises $60M, account-to-account payment grows." 4th October 2023. https://techcrunch.com/2023/10/04/open-banking-led-to-a-fintech-boom-as-brite-raises-60m-account-to-account-payments-grows/

[20] Finance Magnate. "The adoption of open banking and its impact on the payments industry in the United Kingdom." 17th July 2023. https://www.financemagnates.com/fintech/payments/the-adoption-of-open-banking-and-its-impact-on-the-payments-industry-in-the-united-kingdom/

information from these funding rounds is sourced from Dealroom.co.[21] The advantage of using Dealroom.co instead of other data providers (e.g., Crunchbase or PitchBook) is that it has a strong focus on European startups and tech ecosystems, thus providing more extensive and more accurate data and analysis specific to European markets. Dealroom.co reports a total of 1,034 funding rounds during our sample period (2014–2022), with a total of 456 Spanish fintechs involved. A total of 88 Spanish fintech companies (162 observations) obtained €263,411 million through market funding during the period 2014–2022. The treated fintech companies (Paytech) obtained 20.35% of the total market funding during our sample period.

As we did in the main analysis, we employ a difference-in-differences (DiD) specification to compare alternative market financing between treated companies (those affected by the regulation) and the control group (those not affected) before and after the implementation of PSD2.

To examine access to alternative market funding, it is essential to recognize that this type of equity funding exhibits cyclical behavior. It is well known that fintech companies do not receive market funding on a consistent annual basis. Typically, fintech firms secure funding in phases, often aligning with major milestones such as product launches, regulatory changes, or significant market traction. These phases are characterized by periods of intense funding activity followed by quieter intervals. Using Dealroom.co data, we observe that only 18.56% of fintech companies received funding two or more times within the same calendar year. On average, funding rounds for fintech are separated by approximately 14.89 months. Therefore, the total funding obtained in a given year may depend on the amounts secured in previous years. To account for this variability, we compute the total market funding using a rolling window that includes the current year and the three preceding years. This approach allows us to examine market funding from a more holistic and informed perspective, considering fintechs' strategic planning and decision-making. Additionally, it provides a more comprehensive view of global trends and patterns affecting investors. By including multiple years, we can smooth out short-term fluctuations and capture longer-term trends in funding activity.

As we are interested in the total volume of funding and the ability to secure stable funding, we employ two dependent variables: the total funding obtained in the current year and the three previous years (from t-3 to t), and the standard deviation of the funding obtained within this same period. By examining both the total funding and its stability, we

[21] Dealroom.co is a global provider of data and intelligence on startups, growth companies, and tech ecosystems on startup, early-stage, and growth company ecosystems in Europe and around the globe.

can better understand how open banking regulations influence the financial support landscape for fintech firms, thus providing insight into their ability to attract consistent and substantial investment. Furthermore, recognizing that many fintech firms do not secure alternative funding, we also re-run our models on the subsample of fintech firms that have obtained funding in a given year. This allows us to observe the effect of open banking on the fintech firms that effectively rely on alternative market funding. Finally, we also examine this impact on Paytech firms with a payment license (registered) versus non-registered Paytechs. As licensed Paytechs have to maintain a minimum amount of equity by regulation, we check whether these firms are more likely to obtain this equity in the alternative market.

[INSERT TABLE 13]

Table 13 presents the results of this analysis. While Column 1 indicates no differences in the total volume of funding across the groups of fintech firms, Column 2 reveals that treated fintech entities secure more stable funding, exhibiting lower volatility compared to the control group. This suggests that the implementation of open banking regulations has contributed to a more consistent and predictable funding environment for these firms. The reduced volatility in funding implies that investors have greater confidence in the long-term viability and growth potential of fintech firms operating under open banking frameworks. Additionally, the regulatory framework may have created a more transparent and predictable business environment, reducing uncertainties and encouraging steady investment flows. Ensuring stable funding is relevant because it allows Paytech fintech firms to plan more effectively and reduces the uncertainty that can deter investment, leading to a smoother funding trajectory even if the total volume of investment does not increase significantly. Overall, stable funding helps mitigate risks associated with financial uncertainty, enabling firms to focus on product development, market expansion, and scaling operations.

In our subsample analysis, we find that among fintech firms that have successfully secured funding in a given year (market-funded fintech), Paytech firms are able to raise a higher volume of funding compared to the control group (Column 4 of **Table 13**). This result, in conjunction with the previous findings, suggests that Paytech firms benefit not only from more stable funding but also from a higher volume of funding when they secure investment. Additionally, Column 3 shows no differences in the total volume of funding between Paytech firms with a payment license (registered) and those without (non-registered). This finding indicates that merely having a payment license does not attract more funding. Instead, other factors, such as the business strategy of the Paytech firm or the types of services offered, may be more relevant in attracting investment.

7. Robustness

In this section, we present a series of robustness analyses to enhance confidence in the findings from Section 5. Specifically, we demonstrate that the main results of the paper remain robust across various tests, including anticipatory effects, random assignment, different subsamples, and alternative definitions of treated firms.

7.1. Alternative measures of performance

Firstly, we aim to verify that our performance results remain consistent when alternative performance measures are used. To achieve this, we re-run our regressions with four different performance metrics: operating ROA (EBIT to total assets), EBITDA ROA, ordinary net profits to total assets, and a dummy variable indicating whether profits exceeded the average profits of the preceding three years. **Table 14** illustrates that, across all these measures, Paytech fintech firms demonstrate higher performance compared to the control group following the implementation of PSD2.

[INSERT TABLE 14]

7.2. Subsample analyses

To ensure that our results are not influenced by a specific subset of fintech firms in our sample, we conduct several subsample analyses. The results are shown in **Tables 15, 16, and 17.** Firstly, we restrict the sample to those fintech–year observations where the data reported, according to the Central Balance Sheet Data Office at the Bank of Spain, comply with the established quality standards.[22] By doing so, we ensure that our results are not affected by potential misstatements in the accounting information reported by the firms. Column 1 of the three tables shows that the results hold.

Additionally, we re-run our model by extending the sample period to 2012–2022. This extension ensures that our findings are not influenced by earlier trends in the fintech sector's evolution during the period when the First Payment Services Directive (PSD1) was in effect. The results (Column 2) remain consistent with this extended sample period, confirming the robustness of our findings.

Furthermore, we exclude the year 2020 from our analysis to avoid biases introduced by the COVID-19 pandemic's impact on performance, access to funding, and investment behavior. This exclusion ensures that our findings are not distorted by the unique economic

[22] The Central Balance Sheet Data Office of the Bank of Spain sets several quality standards to ensure the accuracy and reliability of the collected data. These standards include data accuracy and completeness, uniformity in data presentation, validation and verification, and confidentiality and security.

conditions brought about by COVID-19. As can be observed in Column 3 of **Tables 15, 16, and 17**, the results are qualitatively similar.

Column 4 of **Tables 15, 16, and 17** provides the results for the subsample of firms classified as micro firms (fewer than 10 employees) to ensure that our results are not driven by the largest fintech firms. This threshold is relevant since, on average, fintech firms have seven employees. Our analysis shows that even when focusing on the smaller fintech firms, the main results of the paper hold.

In Column 5, we limit the sample to only those firms categorized under the CNAE (NACE) activity code[23] as technological firms (code M and N) or financial firms (code K). This analysis helps ensure that our sample effectively consists of fintech firms, whose activities should be classified as technological or financial by definition. In essence, this analysis acts as a filtering process to identify fintech firms, complementing the classification provided by the FinTech Radar of the Bank of Spain. By doing so, we confirm that the firms included in our study genuinely belong to the fintech sector, thereby validating the robustness of our results. As can be observed, the results are qualitatively similar.

Finally, in Column 6, we exclude firms located in fintech clusters such as Madrid, Barcelona, and Valencia from our analysis. This filtering process helps us demonstrate that our findings are not driven by fintech firms located in these clusters, which may have better access to customers and funding. By excluding these firms, we ensure that our results are representative of the broader fintech sector and not biased by the unique advantages of firms in these highly concentrated areas. The results hold for this subset of fintech firms.

In this set of subsample analyses, it is noteworthy that the proportion of treated firms remains constant across the subsamples and is similar to the share of treated firms in the whole sample (12.06%). This consistency suggests that our subsampling criteria do not disproportionately affect the distribution of treated versus control firms, thereby reinforcing the robustness and validity of our findings across different analytical conditions.

[INSERT TABLE 15]

[INSERT TABLE 16]

[23] The CNAE code, or *Clasificación Nacional de Actividades Económicas*, is the Spanish national classification system for economic activities. It is used to categorize businesses and other entities based on their primary economic activities. The CNAE system is aligned with the NACE (*Nomenclature des Activités Économiques dans la Communauté Européenne*), which is the statistical classification of economic activities in the European Community.

[INSERT TABLE 17]

7.3. Anticipation effects

As discussed in Section 3.1, although PSD2 came into force in January 2018, it was enacted in 2015. Therefore, effects of the policy may have been anticipated. To account for this possibility, we perform a DiD analysis, considering the post-treatment period starting in 2016. To maintain the same number of years before and after treatment, we use the sample period from 2012 to 2019. The results, shown in Columns 1 to 3 of **Table 18**, maintain the expected signs (positive for ROA and negative for bank and long-term bank debt) but are not statistically significant. This result provides no evidence of anticipation effects. Therefore, our findings suggest that firms did not alter their behavior in response to the policy before it was fully implemented.

[INSERT TABLE 18]

7.4. Random assignment

As is standard in the DiD literature, we employ an algorithm to assign the treatment randomly, so that fintech firms are randomly categorized as treated or controls, and we re-run the model. The results presented in **Table 18** are not significant. This placebo test indicates that our benchmark results cannot be attributed to random sources, thereby reinforcing the robustness of our findings.

7.5. Analysis of licensed fintech firms

As explained in Section 4, following PSD2, Strong Customer Authentication (SCA) was implemented, and new types of Third-Party Payment Providers (TPPs) emerged that could initiate payments and use data from banks: Payment Initiation Service Providers (PISP) and Account Information Service Providers (AISP). Since these entities were directly affected by PSD2 and require a license to operate, we conduct a robustness analysis focusing on the original treated firms with payment licenses, including AISP, PISP, and Electronic Money Institutions. In this case, the treated firms are those Paytech fintech firms that have a payment license (registered) as EMIs, AISPs, or ASPSPs, while the control group consists of fintech firms that do not engage in payment activities. The results, shown in **Table 19**, are consistent with the previous findings but reveal a much stronger impact on the performance of these firms. Specifically, the increase in performance (ROA) is 27.7% compared to the original 23%, which is expected, as these firms were most affected by PSD2. However, the results for bank funding show a smaller decrease of -4.8% compared to -8.1% in the original sample, and long-term funding shows a decrease of -11% compared to -6.1% in the original

sample. These findings suggest that while profitability improved significantly for licensed firms, their access to bank funding did not decrease as sharply as initially observed in the broader sample.

[INSERT TABLE 19]

8. Conclusion

Open banking initiatives implemented globally are enhancing competition within the financial services sector. Understanding how these regulatory changes impact all financial agents is highly relevant, as it makes it possible to assess the alignment of real economic outcomes with the preamble underpinning new policy interventions.

For this reason, this paper used the adoption of the Second Payment Services Directive (PSD2) as a unique setting to empirically examine the impact of this open banking initiative on the development of the fintech sector, focusing on those fintech firms offering payment-related financial services. The implementation of PSD2 in 2018 provided an ideal laboratory to answer our research question, as it is a payments-focused open banking framework that creates an intertwined policy intervention by allowing third-party providers (TPPs) to access banks' data while simultaneously improving the convenience and security of digital payments. This setting allowed us to identify the specific types of fintech firms (Paytech fintech firms) that are particularly affected by the implementation of this initiative. There is evidence suggesting that open banking can present both opportunities (e.g. Fuster et al., 2019; Gambacorta et al., 2024; Ghosh et al., 2021) and risks (e.g. Frei, 2023) for traditional banks and fintechs, which highlights the importance of careful policy design and risk management to mitigate potential downsides.

In this study, we focused on the effects of PSD2 on fintech performance, funding structure, and broader economic outcomes, employing a difference-in-differences methodology. Our analysis was conducted using a rich and granular panel dataset of 406 Spanish fintech firms ranging from 2014 to 2022. This microdata was sourced after matching a census of fintech firms from the Fintech Radar at the Bank of Spain with detailed balance sheet information from the Central Balance Sheet Data Office. We used a dual strategy, relying on qualitative information from FinTech Radar and expert judgment, to identify 49 fintech firms as belonging to the treated (Paytech) group.

Our findings indicate that the implementation of PSD2 had a positive and significant impact on the performance of fintech firms involved in payment services. Specifically, treated fintech firms experienced a 23% average improvement in return on assets (ROA) compared

to the control group. This improvement was primarily driven by the income-growth channel, suggesting that these firms leveraged access to customer data to enhance their revenue streams rather than to reduce costs. The positive impact on performance was less pronounced for larger, more solvent, and more indebted firms, indicating that smaller, less capitalized fintech firms benefited more from the regulation.

In terms of funding structure, treated fintech firms showed a significant reduction in reliance on long-term bank debt, with an approximately 10% average decrease in bank debt compared to the control group. This shift was not offset by an increase in non-bank debt, suggesting a move towards alternative financing strategies, such as equity funding. The cost of funding remained unchanged, but the interest burden decreased, reflecting better financial health and reduced financial risk for treated firms. Furthermore, in a more detailed analysis, we examined the extent to which the implementation of the open banking regulation has fostered access to alternative market funding for Paytech firms. Specifically, treated fintech firms secured more stable funding, exhibiting lower volatility compared to the control group. Among the fintech firms that successfully secured funding in a given year (market-funded fintech firms), Paytech firms were able to raise a higher volume of funding.

Our analysis of economic outcomes revealed that compared to control firms, treated fintech firms invested less in intangible and tangible assets, prioritizing liquidity over long-term investments. Additionally, these firms exhibited reduced labor intensity but increased labor costs, indicating a shift towards higher-skilled, more expensive labor. This change contributed to higher productivity among treated firms.

The robustness of our results was confirmed through various checks, including tests for anticipatory effects, random treatment assignments, and analyses of different samples. The findings remained consistent, reinforcing the conclusion that PSD2 has significantly influenced the growth and development of the payments spectrum of the fintech sector.

The findings of this study are derived from the specific context of the Spanish open banking ecosystem, which is characterized by the central role of Redsys as the primary API provider for banks and third-party providers (TPPs). This unique setup, with a single dominant infrastructure provider, facilitates standardized access and interoperability, potentially influencing the uniformity of adoption and outcomes observed in the study. In a sense, this could be seen as an positive outcome as the forthcoming Payment Services Directive 3 (PSD3) emphasizes the need for standardized APIs to enhance interoperability and efficiency within the EU's financial ecosystem and also to reduce entry barriers for FinTech companies and streamline access to financial account data. However, this fact may

differ significantly from the open banking frameworks in other jurisdictions, where multiple API providers operate, creating diverse competitive and technical dynamics. Further research could also explore the relevance of adopting an open banking framework depending on the degree of fragmentation or centralization in open banking infrastructures.

Open banking regulations, such as PSD2, have a broad range of implications for banks, payment providers, third-party providers, and consumers. While it is important to recognize that these initiatives impact not only fintech firms but also other entities, the effects on banks and credit institutions are beyond the scope of this paper. Future research could explore these broader impacts, potentially providing a more comprehensive understanding of open banking initiatives' influence on the entire financial sector

Overall, this paper contributes to the literature on open banking by providing empirical evidence on its effect on non-bank competitors, especially Paytech fintech firms. It also furthers understanding of the fintech ecosystem, highlighting how regulatory changes can shape the performance and funding structure of fintech firms. These insights are valuable for policymakers and stakeholders aiming to foster innovation and competition in the financial sector through data-driven financial regulations. Our findings can serve as input to policymakers' decisions regarding the regulation of this increasingly important sector for the financial system. In the case of PSD2, since this regulation aimed to increase competition and promote the growth and strengthening of the payments sector, our findings confirm that the policy has achieved its objectives within the payment fintech sector.

Appendix

Table A.1. Definition of variables

Variable	Definition
Performance	
ROA_{it}	Return on assets at the end of year t
ROE_{it}	Return on assets at the end of year t
Growth of assets	Annual growth rate of firms' assets
Growth of capital	Annual growth rate of firms' capital
$\triangle$Income	Annual growth rate of output value (sales + change in stock)
∇Costs	Annual growth rate of operating costs (inputs + personnel expenses)
Operating ROA_{it}	EBIT to total assets at the end of year t
EBITDA ROA_{it}	EBITDA to total assets at the end of year t
Ordinary Net $Profits_{it}$	Ordinary net profits to total assets at the end of year t
High-$Profitable_{it}$	Dummy variable taking the value 1 if profits at the end of year t exceeded the average profits of the preceding three years
Funding	
Bank debt to $assets_{it}$	Ratio of total bank debt (long-term and short-term) to total assets at the end of year t
Bank debt to $liabilities_{it}$	Ratio of total bank debt (long-term and short-term) to total liabilities at the end of year t
Non-bank debt to $assets_{it}$	Ratio of total non-bank debt (long-term and short-term) to total assets at the end of year t
Non-bank debt to $liabilities_{it}$	Ratio of total non-bank debt (long-term and short-term) to total liabilities at the end of year t
Long-term bank debt to $liabilities_{it}$	Ratio of total long-term bank debt to total liabilities at the end of year t
Short-term bank debt to $liabilities_{it}$	Ratio of total short-term bank debt to total liabilities at the end of year t
Cost of $funding_{it}$	Ratio of interests on borrowed funds to total debt (bank and non-bank) at the end of year t
Interest $burden_{it}$	Ratio of interests on borrowed funds to the sum of gross operating profit and financial revenue at the end of year t
Real economic outcomes	
Tangible assets $(\%)_{it}$	Ratio of tangible assets to total assets at the end of year t
Intangible assets $(\%)_{it}$	Ratio of intangible assets to total assets at the end of year t
Financial investments $(\%)_{it}$	Ratio of investments on financial assets to total assets at the end of year t
Current assets $(\%)_{it}$	Ratio of current assets to total assets at the end of year t
$\triangle$Employees	Dummy taking the value 1 if the number of employees has increased compared to the previous year
Employees to total $assets_{it}$	Natural logarithm of the ratio of total workers to total assets
Cost of $labor_{it}$	Ratio of labor costs to total operating costs
$Productivity_{it}$	Ratio of output value of production to the value of total inputs
Controls	
$Size_{it-1}$	Natural logarithm of total assets at the end of year t-1
Asset $structure_{it-1}$	Ratio of current assets to total assets at the end of year t-1
$Solvency_{it-1}$	Ratio of total equity to total assets at the end of year t-1
$Leverage_{it-1}$	Ratio of total liabilities to total equity at the end of year t-1
Efficiency $Ratio_{it-1}$	Ratio of operating revenue to the total sum of equity and noncurrent liabilities computed at the end of year t-1
Liquidity $Ratio_{it-1}$	Ratio of current assets to current liabilities computed at the end of year t-1
Age_{it-1}	Number of years since the fintech was created at the end of year t-1

Table A.2. Sources employed by FinTech Radar and type of information provided

Source of information	Information gathered
EBA Payment Institution Register	Activities, registration numbers, dates of registration
Bank of Spain Official Registry of Entities	Activities, registration numbers, dates of registration
Crypto assets and electronic wallet service providers and Real State Lending intermediaries (Bank of Spain Registry)	Activities, registration numbers, dates of registration
CNMV's Official Registry of Entities	Activities, registration numbers, dates of registration
List of crowdfunding providers registered in CNMV	Activities, registration numbers, dates of registration
News in digital media (e.g. *El Referente*, gen beta, *El Economista*)	Detailed activity, related firms, headquarters, verification that the company is active (sometimes the webpage is not working, or the domain is for sale), technologies that are used, geographies, funding rounds
FinTech webpage	Detailed activity, related firms, headquarters, verification that the company is active (sometimes the webpage is not working, or the domain is for sale), technologies that are used, geographies…
Finnovating platform	Headquarters, technologies that are used, geographies, funding rounds
Informa / Axesor	TIN, date of establishment, NACE code, relevant facts (e.g., company going into liquidation)
Fintech mapping of the EU Digital Finance Platform	Fintech brand names
FinTech map of the Spanish FinTech and InsurTech Association (AEFI)	Fintech brand names
BdE Statistics Department's Fintech Observatory	Fintech brand names

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Table 1. Breakdown of fintech firms in Fintech Radar and CBI by activity

This table presents the breakdown by activity of fintech firms in Fintech Radar (Column 1) and fintech firms in Fintech Radar with data in CBI (Column 2). Number and percentage of firms are presented.

Activity	Total fintechs in Fintech Radar	Fintech in Fintech Radar with data in CBI
Lending & Crowdfunding	128 (16%)	42 (10%)
Payments	123 (15%)	64 (15%)
Investment	106 (13%)	51 (12%)
Other	437 (55%)	270 (63%)
Total	**794**	**427**

Table 2. Number of treated and control firms per year

This table presents the annual breakdown of treated and control fintech firms from 2014 to 2022. It shows the number of control fintech firms, the number of treated fintech firms, and the percentage of treated firms each year.

Year	# Control fintech firms	# Treated fintech firms	% Treated
2014	130	15	10.34%
2015	152	20	11.63%
2016	163	24	12.83%
2017	181	27	12.98%
2018	191	26	11.98%
2019	222	28	11.20%
2020	238	29	10.86%
2021	209	22	9.52%
2022	83	6	6.74%

Table 3. Summary statistics

This table presents the descriptive statistics – number of observations, mean, median, standard deviation, 25th percentile, 75th percentile – of the main variables of interest. All the variables are defined in Table A1 of the Appendix.

VARIABLES	Observations	Mean	Median	St. Deviation	p25	p75	TREATED	CONTROL
CONTROL VARIABLES							**Mean: 2014–2022**	
Size	1766	6.29	6.28	1.94	5.01	7.67	5.88	6.34
Asset structure	1766	0.63	0.68	0.29	0.39	0.90	0.60	0.63
Solvency	1766	0.31	0.46	0.89	0.19	0.73	0.26	0.32
Leverage	1766	2.07	0.69	9.54	0.15	1.95	3.08	1.94
Efficiency	1766	0.05	0.06	1.15	-0.16	0.35	0.08	0.04
Liquidity	1766	6.22	1.98	18.8	1.05	4.26	4.82	6.40
Age	1766	7.43	5.00	6.98	3.00	10.00	6.49	7.54
MAIN DEPENDENT VARIABLES								
Performance								
ROA	1766	-0.15	0.01	0.67	-0.18	0.08	-0.25	-0.13
ROE	1766	-0.05	0.04	1.95	-0.19	0.34	-0.13	-0.04
Funding								
Bank debt to liabilities	1727	0.17	0.01	0.26	0.00	0.27	0.13	0.17
Non-bank debt to liabilities	1741	0.25	0.01	0.33	0.00	0.49	0.29	0.24
Long-term bank debt to liabilities	1755	0.11	0.00	0.21	0.00	0.12	0.09	0.11
Short-term bank debt to liabilities	1716	0.05	0.00	0.11	0.00	0.05	0.04	0.05
Cost of funding	1600	0.05	0.12	0.18	0.00	0.03	0.03	0.05
Interest burden	1744	0.09	0.01	2.39	-0.01	0.02	-0.02	0.10
Investments								
Tangible assets (%)	1766	0.05	0.01	0.11	0.01	0.03	0.05	0.05
Intangible assets (%)	1766	0.22	0.09	0.27	0.00	0.39	0.30	0.21
Financial investments (%)	1766	0.07	0.00	0.17	0.00	0.04	0.03	0.08
Current assets (%)	1766	0.63	0.68	0.29	0.39	0.90	0.60	0.63
Labor								
△Employees	1766	0.58	1.00	0.49	0.00	1.00	0.58	0.58
Employees to total assets	1766	0.01	0.01	0.02	0.00	0.01	0.02	0.01
Cost of labor	1754	1.16	0.70	4.75	0.18	1.49	1.34	1.13
Productivity	1748	2.48	1.73	3.08	1.05	2.98	2.41	2.49

Table 4. Parallel trends test

This table presents the *t*-tests for the assumption of parallel trends in changes in ROA, ROE, bank debt, and employment between treated fintech firms (Paytech fintech) and control group firms (Non-paytech fintech) for the four years before the implementation of PSD2.

ΔROA	Treated	Control	Diff.	T-test
2014 (t-4)	0.012	0.004	0.008	0.052
2015 (t-3)	0.347	0.118	-0.228	-1.244
2016 (t-2)	-0.017	-0.020	-0.020	-0.029
2017 (t-1)	-0.070	0.012	0.083	0.593
ΔROE	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	-0.300	-0.023	0.276	0.413
2015 (t-3)	0.580	-0.149	-0.729	-1.163
2016 (t-2)	-0.227	0.035	0.263	0.561
2017 (t-1)	0.146	0.003	-0.142	-0.429
ΔBank debt (%liabilities)	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	0.009	0.008	-0.0005	-0.008
2015 (t-3)	0.040	0.007	-0.032	-0.556
2016 (t-2)	0.042	0.021	-0.021	-0.503
2017 (t-1)	-0.018	0.035	0.054	1.196
ΔEmployees (%assets)	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	0.004	0.003	0.001	0.101
2015 (t-3)	-0.004	-0.010	-0.006	-0.307
2016 (t-2)	-0.004	0.007	0.008	0.797
2017 (t-1)	0.018	-0.002	-0.021	-1.427

Table 5. Results on performance

This table presents the results of the difference-in-differences regressions on fintech firms' performance. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	**(1) ROA**	**(2) ROE**	**(3) Growth of Assets**	**(4) Growth of Capital**
Post-PSD2 x Payment FinTech	0.230***	-0.237	-0.186	2.193*
	(0.078)	(0.254)	(1.255)	(1.219)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,766	1,766	1,766	1,769
R-squared	0.459	0.277	0.467	0.221
Number of firms	406	406	406	405

Table 6. Heterogeneous effect on performance (ROA)

This table presents the results of the difference-in-differences regressions on fintech firms' performance. The dependent variable is ROA. *Variable* refers to size (Column 1), solvency (Column 2), indebtedness (Column 3), and age (Column 4). The interaction term, Post-PSD2 x Payment FinTech x Variable, is the DiD term that reflects the heterogeneous effect on performance. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	Dependent variable: ROA			
	Size	**Solvency**	**Indebtedness**	**Age**
	(1)	**(2)**	**(3)**	**(4)**
Post-PSD2 x Payment FinTech	1.095**	0.280***	0.242***	0.245**
	(0.430)	(0.080)	(0.080)	(0.124)
Variable	0.039	-0.137*	0.0003***	-0.010
	(0.027)	(0.080)	(0.00005)	(0.013)
Post-PSD2 x Payment FinTech x Variable	-0.141**	-0.216**	-0.0003***	-0.001
	(0.069)	(0.093)	(0.0005)	(0.007)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,766	1,766	1,766	1,766
R-squared	0.463	0.463	0.475	0.459
Number of firms	406	406	406	406

Table 7. Results on funding: Bank debt vs non-bank debt

This table presents the results of the difference-in-differences regressions on fintech firms' funding. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Bank debt		**Non-bank debt**	
	(1)	**(2)**	**(3)**	**(4)**
Dependent variable	**Bank debt to total liabilities**	**Bank debt to total assets**	**Non-bank debt to total liabilities**	**Non-bank debt to total assets**
Post-PSD2 x Payment FinTech	-0.110**	-0.090**	0.058	0.028
	(0.053)	(0.041)	(0.045)	(0.076)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,727	1,738	1,741	1,752
R-squared	0.628	0.592	0.663	0.691
Number of firms	402	402	406	406

Table 8. Results on funding: debt maturity, cost of funding, and interest burden

This table presents the results of the difference-in-differences regressions on debt maturity (long-term and short-term), cost of funding, and interest burden. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Bank debt		Non-bank debt		Cost of funding & interest burden	
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	**Long-term bank debt**	**Short-term bank debt**	**Long-term non-bank debt**	**Short-term non-bank debt**	**Cost of funding**	**Interest burden**
Post-PSD2 x Payment FinTech	-0.081**	-0.026	0.016	0.044	0.012	-0.277*
	(0.040)	(0.030)	(0.045)	(0.029)	(0.025)	(0.155)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,755	1,716	1,755	1,755	1,342	1,468
R-squared	0.598	0.564	0.686	0.603	0.316	0.196
Number of firms	406	402	406	406	373	387

Table 9. Heterogeneous effect on funding (bank debt)

This table presents the results for the difference-in-differences regression on fintech firms' bank debt. The dependent variable is the ratio of total bank debt (long-term and short-term) to total liabilities at the end of year t. *Variable* refers to size (Column 1), solvency (Column 2), indebtedness (Column 3), and age (Column 4). The interaction term, Post-PSD2 x Payment FinTech x Variable, is the DiD term that reflects the heterogeneous effect on performance. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: Bank debt			
	Size	Solvency	Indebtedness	Age
	(1)	(2)	(3)	(4)
Post-PSD2 x Payment FinTech	-0.109	-0.011**	-0.011**	-0.079
	(0.077)	(0.053)	(0.052)	(0.067)
Variable	0.016*	0.001	-8.32e-07	-0.001
	(0.009)	(0.007)	(0.0001)	(0.005)
Post-PSD2 x Payment FinTech x Variable	-0.00001	0.015	9.78e-07	-0.003
	(0.011)	(0.026)	(0.0001)	(0.006)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,727	1,727	1,727	1,727
R-squared	0.628	0.628	0.628	0.628
Number of firms	402	402	402	402

Table 10. Results on funding: firms' investments and liquidity

This table presents the results of the difference-in-differences regressions on firms' investments (tangible assets, intangible assets, and financial investments) and liquidity (current assets). The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Investments			Liquidity
	(1)	(2)	(3)	(4)
Dependent variable	**Tangible assets to total assets**	**Intangible assets to total assets**	**Financial investments to total assets**	**Current assets to total assets**
Post-PSD2 x Payment FinTech	-0.004	-0.064*	-0.024*	0.088**
	(0.016)	(0.034)	(0.014)	(0.035)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,766	1,766	1,766	1,766
R-squared	0.785	0.804	0.730	0.775
Number of firms	406	406	406	406

Table 11. Results on funding: employment, cost of labor, and productivity

This table presents the results of the difference-in-differences regressions on employment, cost of labor, and productivity. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Employment		Cost of labor	Productivity
	(1)	(2)	(3)	(4)
Dependent variables	**ΔEmployees**	**Employees to total assets**	**Wages to total costs**	**Output value to input value**
Post-PSD2 x Payment FinTech	-0.180**	-0.006*	0.886***	0.762*
	(0.083)	(0.003)	(0.340)	(0.411)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,773	1,766	1,754	1,748
R-squared	0.424	0.645	0.277	0.577
Number of firms	406	406	406	406

Table 12. Performance channel

This table presents the results of the difference-in-differences regressions on the annual growth rate of fintech firms' output value (Column 1) and the annual growth rate of fintech firms' costs (Column 2). The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	△Income (1) Growth of output value (sales + change in stock)	▽Costs (2) Growth of operating costs (inputs + personnel expenses)
Post-PSD2 x Payment FinTech	0.144*	-0.245
	(0.075)	(0.250)
Controls	Yes	Yes
Firm FE	Yes	Yes
Time FE	Yes	Yes
Observations	1,604	1,759
R-squared	0.379	0.374
Number of firms	372	404

Table 13. Alternative market funding

This table presents the results of the difference-in-differences regression on alternative market funding. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	(1) Total funding obtained (from t-3 to t)	(2) SD funding obtained (from t-3 to t)	Subsamples (3) Total funding obtained (from t-3 to t) Registered (treated) vs non-registered (treated)	Subsamples (4) Total funding obtained (from t-3 to t) Market-funded fintech
Post-PSD2 x Payment FinTech	-0.192	-0.180***	1.201	9.409***
	(0.261)	(0.079)	(1.186)	(2.403)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,773	1,773	198	125
R-squared	0.717	0.663	0.832	0.856
Number of firms	406	406	49	72

Table 14. Robustness: Alternative measures of performance

This table presents the results of the robustness checks. The dependent variables are operating ROA – EBIT to total assets (Column 1), EBITDA ROA (Column 2), ordinary net profits to total assets (Column 3), and a dummy variable indicating whether profits exceeded the average profits of the preceding three years (Column 4). The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	**(1) EBIT to total assets (operating ROA)**	**(2) EBITDA ROA (EBITDA/assets)**	**(3) Ordinary net profits to total assets**	**(4) Dummy=1 if profits > average profits (previous 3 yrs)**
Post-PSD2 x Payment FinTech	0.201**	0.206***	0.413**	0.241**
	(0.082)	(0.074)	(0.183)	(0.099)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,766	1,773	1,766	1,773
R-squared	0.476	0.495	0.225	0.294
Number of firms	406	406	406	406

Table 15. Robustness: Subsample analyses on performance

This table presents the results of the robustness checks. The dependent variable is ROA. The analyses are described in Section 7.2. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: ROA					
	(1)	(2)	(3)	(4)	(5)	(6)
	Data accuracy	**Extended sample period (2012–2022)**	**Excluding the effect of the pandemic (excluding 2020)**	**Classified as small firms and micro firms**	**Financial or technological companies**	**Excluding fintech clusters**
Post-PSD2 x Payment FinTech	0.260***	0.198**	0.233***	0.243**	0.278***	0.206*
	(0.077)	(0.082)	(0.090)	(0.096)	(0.096)	(0.113)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,145	1,981	1,499	1,521	1,505	473
R-squared	0.460	0.430	0.484	0.417	0.472	0.510
Number of firms	363	409	395	385	355	109
% treated in subsample	11.09%	11.10%	11.20%	11.83%	11.69%	12.26%

Table 16. Robustness: Subsample analyses on bank debt

This table presents the results of the robustness checks. The dependent variable is the ratio of total bank debt to total liabilities. The analyses are described in Section 7.2. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: Bank debt					
	(1)	(2)	(3)	(4)	(5)	(6)
	Data accuracy	**Extended sample period (2012–2022)**	**Excluding the effect of the pandemic (excluding 2020)**	**Classified as small firms and micro firms**	**Financial or technological companies**	**Excluding fintech clusters**
Post-PSD2 x Payment FinTech	-0.178**	-0.115**	-0.112**	-0.140**	-0.116**	-0.328***
	(0.070)	(0.051)	(0.056)	(0.058)	(0.052)	(0.099)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,115	1,934	1,466	1,486	1,469	465
R-squared	0.676	0.609	0.636	0.634	0.624	0.621
Number of firms	360	405	392	380	350	107
% treated in subsample	11.03%	10.91%	11.11%	11.57%	11.43%	12.04%

Table 17. Robustness: Subsample analyses on long-term bank debt

This table presents the results of the robustness checks. The dependent variable is the ratio of long-term total bank debt to total liabilities. The analyses are described in Section 7.2. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech is treated after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Dependent variable: Long-term bank debt					
	(1)	(2)	(3)	(4)	(5)	(6)
	Data accuracy	Extended sample period (2012–2022)	Excluding the effect of the pandemic (excluding 2020)	Classified as small firms and micro firms	Financial or technological companies	Excluding fintech clusters
Post-PSD2 x Payment FinTech	-0.143**	-0.077*	-0.085*	-0.102**	-0.078**	-0.226***
	(0.057)	(0.040)	(0.043)	(0.044)	(0.036)	(0.078)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,139	1,965	1,490	1,510	1,494	470
R-squared	0.657	0.592	0.603	0.609	0.593	0.645
Number of firms	363	409	395	384	354	109
% Treated in subsample	11.06%	10.99%	11.14%	11.72%	13.09%	12.12%

Table 18. Robustness: Anticipation effects and random assignment of treatment (placebo test)

This table presents the results of the robustness checks. In Columns 1 to 3, the interaction term Post-PSD2 x Payment FinTech takes the value 1 if the year is equal to or after 2016 and the fintech is treated. The sample period is expanded from 2012 to 2019. In Columns 4 to 6, fintech firms are randomly assigned to the treatment group. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	Anticipation effects			Random assignment of treatment (placebo test)		
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	ROA	Bank debt	Long-term bank debt	ROA	Bank debt	Long-term bank debt
Post-PSD2 x Payment FinTech	0.052	-0.089	-0.032	0.056	0.012	0.012
	(0.104)	(0.057)	(0.045)	(0.081)	(0.037)	(0.028)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,394	1,358	1,382	1,766	1,727	1,755
R-squared	0.444	0.663	0.647	0.457	0.625	0.596
Number of firms	340	338	340	406	402	406

Table 19. Robustness: Analysis on licensed (registered) fintech firms

This table presents the results of the difference-in-differences regressions for licensed (registered) fintech firms. In this analysis, the treated firms are those Paytech fintech firms that have a payment license (registered) as EMI, AISP, or ASPSP, while the control group consists of fintech firms without any payment activity. The interaction term, Post-PSD2 x Payment FinTech, is the DiD term that takes the value 1 if the fintech have a payment license (registered) as EMIs, AISPs, or ASPSPs after the implementation of PSD2. All the control variables, year, and firm fixed effects are included but not reported. Clustered standard errors are in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	Registered (Licensed) Payment fintech vs Non-payment fintech		
	(1)	**(2)**	**(3)**
Dependent variables	**ROA**	**Bank debt**	**Long-term Bank debt**
Post-PSD2 x Payment FinTech	0.277*	-0.061*	-0.048*
	(0.158)	(0.034)	(0.028)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Observations	1,621	1,587	1,612
R-squared	0.457	0.636	0.592
Number of firms	371	368	371

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