The Effects of Open Banking on FinTech Firms' Dynamics and Funding Structure

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Abstract

This paper investigates the impact of open banking on the dynamics of fintech firms. Using a unique dataset of Spanish fintech firms from 2014 to 2022, we exploit differential exposure to Europe's open banking regulation between payment-focused fintech firms and other fintech firms. Following the regulation, payment-service fintechs exhibit improved performance and a restructuring of their funding, characterized by reduced reliance on long-term bank debt and increased use of market-based equity. These firms also increase liquidity, reduce labor intensity, raise labor costs, and enhance productivity. These findings provide novel firm-level evidence on the effects of data-sharing regulation in financial markets.

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I. Introduction

Data is at the core of today's businesses. In the financial sector, banks have traditionally maintained strict control over customer data and services. However, the emergence of open banking initiatives worldwide has enabled customer-authorized sharing of financial data among banks and regulated third-party providers (TPPs), with the aim of increasing competition, improving payment services, and mitigating fraud. According to Babina, Bahaj, Buchak, De Marco, Foulis, Gornall, Mazzola, and Yu (2025), up to 80 countries have considered open banking policies, and 49 have implemented them. Among TPPs, fintech firms have emerged as key beneficiaries of open banking initiatives, particularly those focused on payment services, such as payment initiation and account aggregation. By gaining authorized access to bank customers' data, these firms can develop and deliver new financial services. This is crucial, as fintech firms can offer innovative digital solutions that incumbent financial institutions often lack, thus positioning themselves to redesign the financial landscape by reducing operational costs and compressing margins (see, e.g., Cornelli, Frost, Gambacorta, Rau, Wardrop, and Ziegler (2023), Feyen, Frost, Gambacorta, Natarajan, and Saal (2021), and Frost (2020)).

This paper examines how open banking affects fintech firms. We analyze the implementation of Europe's open banking reform, formalized through the Second Payment Services Directive (PSD2), and its effects on fintech performance, investment, labor intensity, productivity, and funding structure using a dataset of Spanish fintech firms from 2014–2022. Given PSD2's regulatory focus on the payments sector, our identification strategy exploits the differential exposure of payment-focused fintech firms relative to fintech firms whose business models do not involve payment processing or payment-account access. We estimate the causal effects using a difference-in-differences design comparing treated and control firms before and after PSD2.

Our results indicate that payment fintech firms directly affected by open banking improved performance relative to the control group. On average, treated firms show a 24 percentage point increase in ROA after PSD2. They also reduce investment in intangible and tangible assets, maintain higher liquidity, and shift toward higher labor costs with lower labor intensity but a greater share of permanent employment, resulting in productivity gains. In terms of funding, treated firms reduce reliance on long-term bank debt and move toward market-based funding. Payment fintech firms obtain larger, more stable, and more frequent equity funding after PSD2. Firms attracting greater external equity financing also reduce their reliance on long-term bank debt the most, consistent with a shift from bank-based to market-based financing following open banking. The changes in performance and funding among payment fintechs appear to be driven mainly by revenue growth, as firms leveraged customer data to boost income and benefited from increased attention from both consumers and investors.

Our findings inform policymakers aiming to promote innovation and competition through data-driven financial regulation. The results also help fintech investors, managers, and entrepreneurs understand how regulatory changes affect firm performance and financing, including capital structure and funding conditions.

This paper contributes to two main strands of the literature: open banking and the fintech ecosystem. Prior studies have shown that open banking improves access to financial services for households and small-to-medium-sized enterprises (Babina et al. (2025) and Nam (2023)), promotes financial inclusion (Fang and Zhu (2023)), fosters competition (Polasik, Huterska, Iftikhar and Mikula (2020)), and increases informational efficiency in borrower selection (He, Huang and Zhou (2023)). However, the adoption of open banking initiatives is shaped by consumer trust and privacy concerns regarding data sharing (Babina et al. (2025), Bijlsma, van der Cruijsen, and Jonker (2023), Parlour, Rajan , and Zhu (2022), and Polasik and Kotkowski (2022)). While prior studies have considered the effects of bank data portability on the profitability of banks (Lin, Zhang, and Zachariadis (2025)) and fintech firms (Peón and Sun (2025)), the broader implications for fintech firm dynamics and funding structures remain underexplored. This paper contributes to the literature on open banking and customer data sharing by providing empirical evidence on how open banking influences fintech firms' competitiveness and financial structure.

Previous research has highlighted how fintech firms have disrupted traditional financial services (Bao and Huang (2021), Thakor (2020), Berg, Fuster and Puri (2022), Boot, Hoffmann, Laeven and Ratnovski (2021), Philippon (2018), and Vives (2019)). The rise of fintech is shaped by multiple factors, such as the relatively high cost of financial services (Philippon (2018)), lack of competition in banking markets (Claessens, Frost, Turner and Zhu (2018), Frost (2020), favorable economic climate (Haddad and Hornuf (2019)), the presence of technology clusters (Laidroo and Avarmaa (2020)), and access to diverse funding sources (Brandl and Hornuf (2020), Haddad et al. (2019)). While existing literature has examined the factors contributing to the performance of these new competitors (Andrikopoulos and Dassiou (2024), Carbó-Valverde, Cuadros-Solas and Rodríguez-Fernández (2022), Salerno, Sampagnaro and Verdoliva (2022)), there is limited research on how data sharing regulations shape 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 dynamics of new financial service providers.

The paper is structured as follows: Section II presents background information on PSD2 and the data. Section III outlines the identification strategy and the methodology used for the empirical analysis. Section IV presents the main findings. Section V explores the channels through which open banking affects fintech firms' dynamics and funding. Section VI reports robustness checks. Section VII concludes and discusses the implications of our findings.

II. Institutional Background and Data

A. The European Open Banking Framework: PSD2

Countries worldwide are adopting open banking to drive innovation, enhance competition, and empower customers within their financial sectors.[1] In the European Union, open banking was established with the approval of the Second Payment Services Directive (PSD2),[2] which came into effect on 13 January 2018. Its objective was to increase competition and innovation in the payments industry while enhancing consumer protection and the security of payment services. Since PSD1 was passed in 2007, there had been significant innovations in the digital payments market, such as the rise of application programming interfaces (APIs) and an increase in online payment fraud.

Notably, PSD2 introduced two major innovations that reshaped the European payments landscape. First, it created a legal framework for TPPs to access customers' payment account data and to initiate payments on their behalf. These TPPs include account information

[1] Babina et al. (2025) 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 2025, more than 70 jurisdictions had implemented or were actively reviewing open banking regulations. This total exceeds 100 when jurisdictions where open banking regulations are under discussion are included.

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

service providers (AISPs) and payment initiation service providers (PISPs). Second, it introduced new security requirements, notably strong customer authentication (SCA) and some regulatory technical standards (RTS) which provide detailed specifications for secure communications between banks and TPPs.

In addition to creating new types of actors (TPPs), PSD2 also imposed obligations on existing payment service providers (PSPs), a broader category that includes banks, electronic money institutions (EMIs), and other licensed entities authorized to execute payment transactions. Although not classified as TPPs, these PSPs are subject to PSD2 provisions, especially those related to customer authentication, transaction security, and interoperability. For instance, EMIs and payment gateways were required to update their technical infrastructure to comply with SCA and RTS protocols and to ensure compatibility with TPP access mechanisms. As a result, even firms not explicitly labeled as TPPs were functionally affected by PSD2, particularly those involved in payment initiation, processing, or wallet-based services.

The PSD2 framework in Europe stands out from other jurisdictions' open banking initiatives due to two main factors. Firstly, PSD2 is a regulatory-driven initiative rather than a market-driven one.[3] 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 TPPs with standardized and secure access to customer data with the users' consent. Consequently, PSD2 simplifies data access for TPPs without the need for lengthy negotiations with each financial institution, thus also increasing customers' trust.

[3]In a market-driven approach, 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.

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 that encompass multiple sectors beyond banking.[4] PSD2's primary focus on the payments sector is clear from its denomination and scope[5], as stated in Article 2.1: "This Directive applies to payment services provided within the Union.". To achieve this, the regulation places special emphasis on introducing open banking services by allowing TPPs to access payment account information and initiate payments. It also focuses on enhancing the convenience and security of digital payments (SCA and RTS).[6] These security measures provide a level of detail and enforceability that distinguishes PSD2 from less stringent regulations in other jurisdictions. This approach is relevant because, by mandating such comprehensive security protocols, PSD2 bolsters consumer trust in digital payments.

B. Data and Sample Composition

To identify fintech firms operating in Spain[7], we rely on the FinTech Radar, a database compiled by the Banco de España using publicly available information[8] from official registers, industry associations, and firms' websites. Firms are classified as fintech according to the

[4]Such as Australia's Consumer Data Right (CDR).

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

[6]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 eases 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.

[7]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. From 2018 to 2024, the total investment in Spanish fintech firms exceeded €1.6 billion.

[8]See Table B2 of the Appendix.

Financial Stability Board's (FSB) definition.[9] The FinTech Radar provides information on firms' business activities, corporate affiliations, headquarters location, fiscal identifiers, incorporation dates, NACE classifications (Nomenclature of Economic Activities in the European Community), registration records[10], operational status, technological infrastructure, and funding history[11]. As of January 2025, the database includes 794 fintech firms identified by unique fiscal identifiers.

To obtain firm-level financial information, we merge the FinTech Radar with the microdata on individual enterprises (CBI) in the Central Balance Sheet Data Office of Banco de España.[12] Because the CBI covers non-financial firms, our analysis focuses on non-bank fintech institutions,[13] while the impact of open banking on banks and other lending institutions lies outside the scope of the paper. By matching the list of fintech firms from the FinTech Radar with the microdata available in the CBI, we construct a panel dataset of Spanish fintech firms with detailed balance-sheet information. Using the CBI, rather than alternative private databases such as Orbis, provides more standardized and comprehensive financial data and

[9] 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

[10] Registration records refer to official company registrations, if the fintech firm holds a license to provide financial services. 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.

[11] Additional details on the construction of the FinTech Radar are provided in Sánchez and Quintanero (2022) and Quintanero et al. (2020).

[12] The CBI has provided annual balance sheet information for individual Spanish non-financial enterprises since 1995. This database is intended 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. The CBI is based on mandatory annual financial statements deposited in the Spanish Mercantile Registries under an agreement between Banco de España and the Spanish Association of Mercantile and Property Registrars (CORPME). https://www.bde.es/wbe/en/areas-actuacion/central-balances/

[13] When matching the FinTech Radar with the CBI, twelve fintech firms dedicated to microlending and four to mortgage intermediation were not matched. Notwithstanding this, for robustness, in Table A16 of the Appendix, we re-run our main regressions including this set of fintech firms in the control group, as they typically do not have direct access to customer information since they do not process payment services. Our results remain qualitatively unchanged.

broader firm coverage. The final sample includes 423 fintech firms with complete balance-sheet information.

Finally, we match our sample (CBI + FinTech Radar) with data on equity funding from Dealroom.co, a database with extensive coverage of European startups and technology ecosystems, including information on funding amounts, number of rounds, investor origin and type, and funding stage. Dealroom.co reports 1,034 funding rounds involving 456 Spanish fintech firms during our sample period (2014–2022). Within our matched sample, 95 fintech firms (178 firm-year observations) received a total of €304,334 million in market funding over this period. Payment fintech firms account for 19.19% of the total market funding.

To ensure that our final sample of fintech firms 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. Table A1 reports the breakdown of firms across payment and non-payment fintech categories and shows that our sample closely mirrors the population distribution, capturing a substantial share of firms in each segment.

III. Empirical Analysis and Methodology

A. Identification Strategy

To identify the causal impact of open banking regulation on fintech firms, we exploit the implementation of the European PSD2 directive as a quasi-natural experiment. Our identification strategy rests on the premise that fintech firms focused on payment services were differentially exposed to this policy intervention compared to firms whose business models do not involve payment processing or access to payment accounts[14].

Consequently, treated firms are fintech firms classified as payment service providers in the FinTech Radar. In our panel dataset, 50 out of 423 fintech firms operating in Spain between 2014 and 2022 fall into this category. These payment services fintechs include nine companies registered with the corresponding licenses as TPPs: three AISPs and six PISPs. The remaining payment fintechs identified by the FinTech Radar as payment services providers are EMIs, electronic wallets, payment gateways, and mobile payments companies. While these firms are not explicitly licensed as TPPs, they were functionally affected by the regulation since PSD2 had broad implications for their operations and strategy. EMIs, though not TPPs, are licensed PSPs authorized to issue electronic money and provide payment services. They are therefore subject to key PSD2 provisions, including SCA and RTS. E-wallets, though they do not issue money themselves, facilitate payment transactions with preloaded or linked funds and often integrate bank transfers and data aggregation. Payment gateways, though they do not initiate payments, act as intermediaries between merchants and acquiring banks, securely routing data and implementing SCA protocols. Mobile payment providers have evolved into multifunctional platforms, offering digital wallets, account-to-account transfers, and PISP/AISP services. Consequently, e-wallets, payment gateways, and mobile payment providers were de facto affected by PSD2. Operating within the payment value chain and relying on licensed partners (EMIs or TPPs), they had to integrate SCA-compliant checkout

[14]Annex I of the European Directive explicitly determines the types of payment services by which a firm could benefit from having access to customers' data (e.g., execution of payments via transfers, cards or direct debits, issuing or acquiring of payment instruments, money remittance, payment initiation, and account information services).

flows, protocols, and APIs, thus experiencing significant technological and strategic adjustments.[15]

By contrast, our control group consists of 373 fintech firms whose business models lie outside the functional and legal scope of PSD2. According to the FinTech Radar, these firms are classified as non-payment services fintech. These include fintechs offering financial software and infrastructure, personal finance, financial advisory services, media and information, real estate, asset management, digital identity, robo-advisory, and social trading. Unlike payment services providers, these fintech firms do not provide or process payment transactions, nor do they require access to customers' payment accounts or bank data to operate. Their core services are built on diverse types of data (e.g., market prices, user-input preferences, public information) and operate under distinct regulatory frameworks that do not fall within the scope of PSD2. While some of these firms could, in principle, benefit indirectly from the reduction of information asymmetries caused by increased data in the financial ecosystem, PSD2 neither mandates nor facilitates data access or interoperability for these categories. Moreover, there are no obligations under PSD2 that apply to their activities in terms of licensing, authentication, or API integration. Thus, the regulatory and operational exposure of these firms differs substantially from that of payment services providers, reinforcing their suitability as a control group. We complement this classification with additional analyses (see Section VI), which confirm that these firms did not experience changes in outcomes attributable to the implementation of PSD2.

B. Difference-in-Differences (DiD) Analysis

[15]The European Banking Authority itself acknowledged that "payment institutions generally see PSD2 as an opportunity, specifically in terms of the security and transparency provisions, as well as regarding the new regulated services, AIS and PIS" (EBA, 2019). This confirms that PSD2 had a direct impact on payment fintechs, irrespective of their specific license.

To address our research question, we employ a difference-in-differences (DiD) specification. Specifically, the DiD approach compares changes in outcomes between treated (*payment services fintech*) and control (*non-payment-services fintech*) fintech firms before and after the implementation of PSD2. To conduct our empirical analysis and to ensure a balanced 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):

$$(1) \qquad y_{i,t} = \beta_0 + \beta_1 (Post\_PSD2_t \ x \ Payment \ FinTech_i) + \beta_2 X_{i,t-1} + \delta_t + \varepsilon_i + u_{i,t}$$

where $y_{i,t}$ represents the dependent variable for firm *i* in period *t*. As indicated above, we focus on two main sets of outcomes: fintech dynamics and funding structure.

First, regarding fintech dynamics, we consider variables that measure the performance, growth, investment, labor intensity, and productivity of fintech firms. To measure performance, we employ a set of variables: return on assets (ROA), return on equity (ROE), 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 (High-Profit). Growth dynamics are proxied by the annual growth rate of the fintech's assets (ΔAssets) and capital (Δcapital). We examine the impact of open banking on firms' investment decisions by distinguishing between different types of investments: tangible assets (%Tangible assets), intangible assets (%Intangible assets), and financial investments (%Financial Investments). Additionally, we incorporate a liquidity ratio (%Current assets). We further investigate PSD2's impact on fintech dynamics in terms of labor intensity (Δ#Employees), labor costs (Labor costs), share of permanent employees (%Permanent employees), and firms' productivity (Productivity). All the variables are defined in Table B1.

Secondly, we analyze the impact of open banking on fintech firms' funding. In doing so, we distinguish between traditional debt funding and alternative equity market funding. The debt funding structure of fintech firms is captured by the ratio of bank debt (non-bank debt) to total liabilities – defined here as financial obligations excluding equity – (Bank debt_liab and Nonbank debt_liab) and total assets (Bank debt_assets and Nonbank debt_assets). By scaling our measures by assets and liabilities, we ensure that the results are not driven by substantial changes in firms' balance sheet structures. Moreover, we also distinguish between long-term and short-term debt. We also compute the cost of debt funding (Debt cost) – defined as the ratio of interest on borrowed funds to total debt – and Interest burden, which is calculated as the ratio of interest on borrowed funds to the sum of gross operating profits and financial revenues.

Finally, we also examine fintechs' access to alternative equity market funding (e.g., seed capital, venture capital, or Series A funding). This is relevant because evidence from media reports suggests that the adoption of open banking has attracted significant investment to payment-focused fintech firms[16]. Moreover, Dealroom.co reports that European payment fintech firms raised €29.7 billion between 2018 and 2024, making them the largest subsector within the fintech ecosystem. Figure A4 illustrates that after open banking was introduced in 2018, a significantly higher proportion of alternative funding went to payment fintechs, with their share reaching almost 40% of all fintech funding in 2020. This trend is also observed in other jurisdictions that have implemented open banking.[17]

[16] "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/

[17] 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/

To examine access to alternative market funding, it is essential to recognize that this type of equity funding exhibits cyclical behavior. Fintech companies do not receive market funding on a consistent annual basis. Typically, they 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, and also in line with prior literature (Conti and Graham (2020), Conti, Dass, Di Lorenzo and Graham (2019), Ralcheva and Roosenboom (2020)), we consider a rolling window to compute total market funding. Specifically, we include the current year and the three preceding years.

To examine the impact of open banking on equity funding, we employ several dependent variables, including the cumulative funding obtained in the current year and the three previous years (Funding volume). To account for the intensive and extensive margin, following Davis, Haltiwanger and Schuh (1996) and Haltiwanger, Jarmin and Miranda (2012), we compute the symmetric growth rate $(\frac{x_t - x_{t-1}}{x_t + x_{t-1}})$ of cumulative funding over firms' equity (ΔFunding_equity). This measure, bounded between –1 and +1, mitigates the distortions of normal growth rates while capturing the magnitude of alternative funding received relative to firms' equity. We also compute the standard deviation of the funding obtained within this same period (SD_Funding). Finally, to capture investors' attention, we consider the total number of investors participating in firm i in year t (#Investors), a dummy variable equal to 1 if firm i received alternative equity funding for the first time in year t (First_Funding), and the time elapsed between consecutive equity funding rounds (Funding_Interval).

$X_{i,t-1}$ includes a set of fintech-level controls. All the independent financial variables are lagged by one period to avoid endogeneity concerns. Fintech size, which is measured using the natural logarithm of total assets, will capture scale effects and access to resources. Asset structure, computed as the ratio of current assets to total assets, controls for the composition of firms' balance sheets and the relative weight of liquid versus fixed assets, reflecting their operational flexibility and short-term investment orientation. Solvency, which is measured as the ratio of total equity to total assets, controls the financial robustness and internal funding capacity of firms. We also consider a measure of fintech efficiency, using the ratio of operating revenues to the total sum of equity and noncurrent liabilities, to capture the firm's ability to generate income relative to its long-term funding structure. Liquidity, measured as current assets to current liabilities, controls for short-term financial flexibility and the firm's capacity to meet immediate obligations. Finally, we consider the age of the fintech firm as the number of years since the firm's founding to account for lifecycle differences and experience effects among firms. 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$_t$ × Payment FinTech$_i$ is our variable of interest. It is the interaction of Payment FinTech$_i$ a dummy that takes the value 1 if the fintech is treated and 0 otherwise, and Post-PSD2$_t$, a dummy that takes the value 1 for 2018 and subsequent years, following the implementation of PSD2, and 0 for earlier years. This interaction is therefore our DiD term, and the estimation of β_1 will capture the causal effect of the treatment on the outcome. Standard errors are clustered at the firm level.

Table 1 reports summary statistics for the key dependent and control variables for treated and control firms,[18] while Table A2 presents the number of treated and control firms per year, with the percentage of treated firms remaining constant at around 11%.

[INSERT TABLE 1]

C. Parallel Trends

To establish the validity of the DiD analysis, we check whether the treated group and the control group exhibit similar trends in outcomes prior to the implementation of open banking. Following 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 firms before the implementation of the treatment. Table 2 presents the *t*-test results for the differences in means between the treatment and control groups over the four years prior to PSD2 implementation in terms of performance (ROA and ROE), funding (bank debt and alternative equity market funding), and employment.[19] All t-test results are insignificant at the conventional value of 5%. 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 2]

[18]See Table B1 for the full definition of the variables.

[19]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.

In addition to the t-test, we conduct an event study to check for pre-trends in the main outcome variables. Figures A1 to A3 plot the dynamic DiD estimates for performance (ROA and operating ROA), debt funding (bank and long-term bank debt), and alternative equity funding (growth rate and total volume). Across all specifications, the coefficients in the pre-treatment period are close to zero and statistically insignificant, confirming the absence of pre-trends and supporting the validity of the parallel trends assumption. The only exception is a slight decline in bank and long-term bank debt one year prior to PSD2, which, though not statistically significant, may indicate an anticipation effect in the substitution of fintechs' funding structures.[20] While the post-treatment coefficients are discussed in detail in Section VI.C., it is reasonable to observe that the slight decline in the coefficient at t = 2 (year 2020) for performance and alternative equity market funding can be explained by the COVID-19 crisis, which temporarily reduced investment activity and profitability across the fintech sector. Subsequently, at t = 3 (year 2021), both coefficients increased again as the global economic environment improved and financial markets stabilized. For bank debt and long-term bank debt, the coefficients remain negative and stable after the implementation of PSD2, consistent with the substitution of bank financing by market-based and equity funding sources.

IV. Baseline Results

A. Fintech Firm Dynamics

1. Performance and Growth Dynamics

Table 3 presents the results of the baseline regression for performance (Columns 1 to 6) and growth (Columns 7 and 8). The adoption of the open banking framework led to improvements in profitability for payment services fintechs. ROA, operating ROA, and

[20] In Section VI.A.5, we explicitly examine possible anticipation and delayed effects in two complementary analyses.

EBITDA ROA are all positive and statistically significant, suggesting that the open banking regulation enhanced operating performance. The profit dummy also becomes significantly positive, meaning that treated firms are more likely to report profits above their three-year historical average. On average, treated firms exhibit a 24 percentage point increase in ROA after the implementation of open banking compared to control fintech firms. This effect is also economically large, as it corresponds to a roughly 150% change relative to the mean ROA over the sample period. It is important to interpret this magnitude in context. Most fintechs in the sample are young and unprofitable, consistent with their startup nature, which makes profitability measures more volatile for these firms than for mature financial institutions. Against this backdrop, the large treatment effect should be understood as reflecting both the structural unprofitability of early-stage fintechs and the strong impact of regulatory change on their business models, rather than as an isolated shift in operating performance.

Moreover, this effect on performance is not driven by a change in firms' assets (Column 7), which could artificially inflate ROA even if profits remained unchanged. However, Column 2 (ROE) of Table 3 shows no significant effect of PSD2 on ROE. This finding should be interpreted together with the results regarding the growth in firms' capital. Column 8 of Table 3 shows that treated fintech firms experienced a larger growth in equity compared to control firms. Consequently, any gains in profitability are offset by increases in equity, leaving ROE unchanged. Since we do not observe a significant increase in total assets but do observe growth in equity, this suggests a shift in capital structure toward greater reliance on equity financing rather than balance sheet expansion.[21]

[21] In Table A3 of the Appendix, we also examine whether the performance effects of open banking are heterogeneous across different firm characteristics (size, solvency, and age) by interacting the DiD term with these variables. None of the coefficients associated with these variables are significant. This means that the post-PSD2 effect on performance in the treated firms is homogeneous by size, solvency, and age.

[INSERT TABLE 3]

2. Investments, Labor Intensity, and Productivity

Table 4 shows that payment services fintechs invest less in intangibles (Column 2) and financial assets (Column 3). The reduced investment in intangible and financial assets suggests that payment services firms may be prioritizing liquidity over long-term investments. This result is consistent with the larger increase in the share of current (more liquid) assets among payment service firms, as shown in Column 4. Overall, this finding suggests that treated fintech firms are not using their profits for large investments and may instead be engaging in liquidity hoarding.

[INSERT TABLE 4]

Regarding the impact on labor demand, Table 4 shows that payment services fintechs exhibit lower growth rates of total employees (Column 5). However, they have increased their labor costs (Column 6). This finding suggests a shift from low-skill to high-skill labor, with the latter being inherently more expensive, because of the need for specialized skills in technology development, data analysis, and regulatory compliance. Furthermore, when examining changes in workforce composition (Column 7), we find that payment services fintechs exhibit a higher ratio of permanent to non-permanent employees after the adoption of open banking.[22] A higher share of permanent contracts typically signals a shift toward more qualified, specialized, and stable positions, consistent with the idea that post-PSD2 payment fintechs increasingly rely

[22]The reduction in the number of observations is due to missing information on workforce composition – data on the number of permanent and temporary employees – in the Banco de España´s CBI database. Furthermore, the regressions are restricted to firms with at least one employee of each type to better capture changes in workforce composition.

on skilled labor. Finally, these treated firms exhibit higher productivity (Column 8), which also reflects the effective utilization of specialized, highly skilled labor.

B. Funding Structure

1. Traditional Debt Funding

To examine the effect on debt funding, we use a sequential approach. Firstly, we explore treated fintech firms' use of bank and non-bank debt (e.g., trade credit, bonds, and government loans). After the implementation of the open banking framework, payment services fintechs rely less on bank debt compared to other fintech firms (Columns 1 and 2 of Table 5, that reports the effects of PSD2 on fintech firms' debt funding structure). On average, post-PSD2 treated firms show a 10.9 percentage point reduction in bank debt relative to total liabilities compared to the control group. This effect is economically large, corresponding to a decline of roughly 64.1% relative to the sample mean of bank debt to total liabilities, and highlights that PSD2 was associated with a shift away from bank financing. However, as shown in Columns 3 and 4, the negative effect on bank debt is not offset by an increase in non-bank debt. 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.

We also explore the maturity of the debt and the cost of funding.[23] The effect on bank debt seems to be driven by payment services fintechs relying less than other fintechs on long-term bank debt after PSD2 implementation (Column 5). On average, treated firms exhibit an 8.2 percentage point decrease in long-term bank debt. Taken together with the result for total bank debt in Column 1, this finding suggests that the overall decline in bank financing is driven

[23] 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.

primarily by reductions in long-term bank debt, which does not appear to be compensated for by an increase in short-term bank debt (Column 6). Moreover, we observe an increase in short-term non-bank debt (Column 8), suggesting that payment services fintechs may have partly replaced long-term bank financing with more flexible borrowing, such as trade credit, factoring, or short-term private loans from non-bank sources.

Finally, we also examine the impact of the open banking framework on the cost of funding and interest burden. The cost of bank funding does not seem to be affected by the open banking framework (Column 9), with payment services fintechs experiencing neither an increase nor a decrease in the financial costs (interest paid) of their debt compared to the control group. However, there is a decline in the interest burden of the treated fintech firms (Column 10), suggesting that after the implementation of the open banking regulation, payment services fintechs exhibit better financial health and reduced financial risk compared to other fintech firms.[24]

[INSERT TABLE 5]

2. Alternative Equity Market Funding

The results presented in Section IV.B.1 suggest that the implementation of the open banking framework has led payment services fintechs to a shift towards alternative financing strategies, such as equity financing.

Table 6 presents the results on alternative equity market funding. While Column 1 shows no differences in the total volume of alternative equity financing between treated and

[24] In Table A4 of the Appendix, we also examine whether the effects of open banking on bank debt are heterogeneous across different firm characteristics (size, solvency, and age) by interacting the DiD term with these variables. 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, and age.

control fintechs, Column 2 shows that payment services fintechs raising equity funds for the first time after PSD2 obtain significantly larger amounts, suggesting that the open banking framework may have acted as a catalyst for attracting investors to new entrants. For most of these firms, accessing alternative equity financing represents a new and critical step in their growth. In this sense, the benefits of open banking may be more pronounced for younger payment services fintechs entering the funding market for the first time than for established players. Using the Davis et al. (1996) and Haltiwanger et al. (2012) symmetric growth rate of cumulative funding scaled by firms' equity (Column 3), we find that payment services fintechs exhibit a higher growth rate in equity funding amounts after PSD2, suggesting that these firms were able to expand their access to external equity financing at a faster pace relative to the control group.

Furthermore, we also re-run our models on the subsample of fintech firms that have obtained funding in a given year (equity-market-funded fintech firms). Within this group, payment services fintechs raise larger funding amounts (Column 4) and exhibit more stable funding (Column 5). This finding is important, as greater funding stability enables these firms to plan more effectively and reduces uncertainty that may otherwise deter investment, thereby supporting a smoother funding trajectory.

Payment fintech firms attract more investors per round on average (Column 6), pointing to a broadening of their investor base and heightened visibility in the market. Column 7 shows that payment fintechs have a higher likelihood of being first-time fundraisers among equity-market-funded fintech firms. Finally, Column 8 shows that the time between consecutive funding rounds shortened significantly for treated firms, consistent with an acceleration of their funding cycles and with more regular access to alternative equity financing[25].

[INSERT TABLE 6]

Moreover, in Table 7, we examine whether the alternative equity funding received is larger for those firms that have reduced bank debt, particularly long-term bank debt, more intensively. The three-way interaction (Post-PSD2 x Payment FinTech x Amount Funding) indicates that the substitution away from bank financing is more pronounced among firms raising more equity funding. This pattern is consistent with payment fintech firms rebalancing their funding structure by increasingly relying on venture capital, private equity, and other alternative investors to finance growth, rather than maintaining relationships with banks for long-term credit.

[INSERT TABLE 7]

Furthermore, we analyze whether the effects of PSD2 differ across stages of venture capital investment. This is relevant because financing through venture capital could clarify the growth stage of firms, as venture capital (VC) financing typically follows a staged progression. Firms initially raise early-stage VC to fund product development and market entry, then attract late-stage VC as they scale operations, and finally secure growth equity financing when approaching maturity or a potential IPO. In doing so, we estimate the model using as the dependent variable an indicator equal to one if the fintech firm receives funding in a given VC

[25] In the subsample of firms with alternative market funding (Table 6, cols. 4–8), 7 out of 74 firms (9.46%) are treated payment fintech firms. In the full sample, 50 out of 423 firms (11.82%) are treated. The proportion of treated firms, therefore, remains roughly stable across samples.

stage-year, and zero otherwise. The resulting coefficients capture changes in the probability of accessing different types of venture capital funding after the implementation of PSD2.

Table 8 shows that payment services fintechs receive more late-stage VC funding (Column 2), while early-stage VC investment declines (Column 1) and growth-equity VC shows no discernible change (Column 3). Open banking may have facilitated the transition of these firms from the early to the later stages of venture capital financing. However, the absence of an effect on growth equity VC implies that most of these firms had not yet reached the maturity required to attract pre-IPO or large institutional equity investors.

[INSERT TABLE 8]

Finally, we also examine whether the composition of investors in alternative equity market funding rounds changed for payment fintechs after the adoption of PSD2, with a particular focus on bank and non-EU investors[26]. Banks can play a dual role in the fintech ecosystem: as competitors in payment services but also as potential strategic investors seeking to acquire technology, market access, or partnerships. The results (Table A5) show no significant effects for bank investors in either the full sample (Column 1) or the subsample of equity-funded fintechs (Column 3). This suggests that after PSD2, banks remained cautious regarding direct investment in fintech competitors. Turning to non-EU investors, a different pattern emerges. In the full sample (Column 2), the coefficient is not statistically significant. Yet, in the subsample of fintechs that raised equity funding (Column 4), the coefficient is significant at 1%. Open banking could have enhanced the visibility of European payment fintechs, making them more attractive to international capital providers.

[26]The variables "Bank investor" and "Non-EU investor" used are constructed using information obtained from Dealroom.co, which provides detailed data on the identity and characteristics of investors participating in each funding round.

V. Potential Channels

A. Revenue-Driven versus Cost-Driven Channels

There are two main channels by which firms can become more profitable: a revenue-driven channel and a cost-driven channel. The revenue-driven channel focuses on increasing sales and revenue, enabling firms to generate additional profits, while the cost-driven channel focuses on improving cost efficiency, enabling firms to maintain their income sources while cutting operational expenses.

Payment fintech firms may have increased revenues through personalized services, broader market reach, and innovative products, reflecting improved access to customer financial data under open banking and enhanced payment security. Moreover, payment fintech firms may have improved performance through greater operational efficiency and productivity. As both channels could be driving the improved performance, we examine their relative contributions to better understand the primary drivers of profitability.

To test the revenue and cost-driven channels, we use the annual growth rate of total sales and changes in stock (△Output value) and the annual growth rate of total inputs and personnel expenses (△Op. costs), respectively. The signs of the coefficients in Table 9 support the revenue-driven channel.

[INSERT TABLE 9]

B. Investors' and Consumers' Attention

As an additional mechanism, we examine whether the increase in performance and the attraction of equity investors could be explained by a rise in both investors' and consumers' attention. Prior studies have shown that search intensity is a good proxy for investors' attention (Da, Engelberg and Gao (2011)) and consumers' demand (Vosen and Schmidt (2011)). We use the Google Trends index to capture firm visibility and public interest, which may reflect adoption and revenue potential, while also signaling market momentum to investors and increasing attractiveness for alternative equity financing.[27]

Payment fintechs experienced an increase in Google search intensity after the implementation of open banking (Column 3 of Table 9). This finding is consistent with the idea that PSD2 not only reshaped the regulatory and competitive environment but also heightened public attention on payment fintechs. This increase in visibility and attention may have raised consumer demand for payment fintechs, boosting their revenues (as shown in Section V.A) and greater investor attention, making these firms more appealing investment targets and ultimately facilitating higher levels of equity funding.

C. Internal Growth

Finally, we investigate whether the increase in performance observed after the adoption of PSD2 translated into greater internal capitalization through retained earnings.

The results in Column 4 of Table 9, however, do not provide evidence in favor of this mechanism. Internal growth through retained earnings did not play a central role in explaining the decline in bank debt and the rise in equity financing after PSD2. Instead, the evidence points to external channels –particularly consumer and investor attention and the inflow of alternative equity investors –as the primary drivers of the funding shifts.

VI. Robustness

[27]Da et al. (2011) show that Google search intensity is a reliable proxy for investor attention, predicting trading volume and market movements. Vosen and Schmidt (2011) demonstrate that Google Trends outperforms traditional survey indicators in forecasting private consumption, validating its use as a measure of consumer demand.

A. Challenges to Identification

Although our identification strategy is carefully designed, we implement a set of robustness tests to assess the reliability of our approach.

1. Licensed and Non-licensed Payment Fintechs

There is heterogeneity within the treated group. Nine treated firms hold a payment license (EMI, AISP, or PISP), while the remainder do not. A related concern is that licensed treated firms (TPPs) may be directly affected by PSD2, whereas others are indirectly affected through broader regulatory and technological changes. To address this issue, Table A6 re-runs the baseline regressions, defining the treated group as payment-services fintechs holding a payment license (EMI, AISP, or ASPSP), while the control group remains the same as in the benchmark exercise. Table A7 instead defines the treated group as payment-services fintechs without a license, while the control group is unchanged.

In both cases, the estimated effects are similar to the main findings of the paper. Regarding economic significance, compared to the baseline estimations, the analysis restricted to licensed payment services fintechs reveals a larger increase in ROA – 32.8 percentage points versus 24 pp in the baseline – but a smaller reduction in bank debt – 6 pp versus 10.9 pp.

2. Control Group: Excluding Robo-advisors and Asset-managers

As an additional robustness check, we restrict the control group to fintech firms least likely to benefit from PSD2-type data access. Specifically, we exclude robo-advisors and asset-management fintech firms from the control group, as these segments may indirectly benefit from banking data even if not directly targeted by open banking regulation. The results reported in Table A8 remain unchanged, and the magnitude of the treatment coefficients increases slightly, reinforcing the interpretation that our findings are driven by PSD2-induced effects on payment fintech firms rather than broader fintech dynamics.

3. Resampling of the Control Group

To evaluate the robustness of the estimated treatment effect to the composition of the control group, we perform a resampling exercise by repeatedly selecting random subsets of control firms. In each of 1,000 iterations, the set of treated firms is kept fixed, while a random subset of 150 to 350 control firms is drawn from the full pool of non-treated fintechs. We then re-estimate the baseline specification on each resampled dataset.

Figure A5 shows the distribution of the estimated DiD coefficients and their p-values for ROA, bank debt, and equity-funding growth. For ROA (Graph A5a), the coefficients cluster around the benchmark estimate (+0.23), and about 99% of iterations yield significance at the 10% level. For bank debt (Graph A5b), the distribution centers on –0.10 (close to the –0.109 estimate in Table 5), with significance in roughly 85% of iterations. For equity-funding growth (Graph A5c), the distribution is also centered on the benchmark estimate, and the coefficient is significant in 78% of iterations. Overall, these patterns indicate that our main results are not driven by the specific composition of the control group.

4. Placebo Test with Random Treatment Assignment

To test whether our estimated effects could arise purely by chance, we conduct a placebo exercise based on random assignment of the treatment. In each of 1,000 iterations, we randomly select 50 firms (the same number contained in the actual treated group) and assign them to the treatment group, creating a placebo treatment indicator that is then used to re-estimate the model.

Figure A6 presents the histograms of the estimated coefficients and corresponding p-values from the placebo experiment. The distributions are centered around zero for ROA, bank debt, and the growth rate of equity funding, with estimated effects significant only about 10% of the time, which is consistent with the random nature of the exercise. This confirms that the original treatment effects do not arise spuriously under random assignment and validates the choice of our control group, since an effect of PSD2 is observed only for treated firms.

5. Anticipation Effects

As discussed in Section II.A, although PSD2 came into force in January 2018, it was enacted in 2015. Thus, the staggered implementation of PSD2, particularly due to the gradual enforcement of SCA and RTS, could challenge our identification. Here, we address possible anticipation and delayed effects by conducting two complementary analyses.

Firstly, to assess whether the estimated effects could be driven by pre-existing dynamics or unrelated trends, we conduct a test in which we shift the treatment year. We reassign the treatment year to each year from 2014 to 2022, recalculating the placebo treatment indicator (did_placebo) and re-estimating the model within a symmetric window of four years before and four years after each placebo treatment year (Figure A7). For ROA, the coefficient is significant only in 2018 (the actual policy year), and far from significant in all other years. For bank debt, the coefficient is significant in 2018 but also shows a significant and stronger effect in 2017. This could reflect a possible anticipation effect, which is plausible when examining firms' funding, as financial (equity) markets and banks may have adjusted expectations ahead of the formal implementation of PSD2. In contrast, anticipation is unlikely for revenue or performance variables, which can only respond after the policy changes business operations. Finally, for the growth rate of equity funding, we observe that the growth of alternative finance also seems to have an anticipation effect, suggesting that alternative equity finance becomes a relevant source of funding at the same time as bank debt decreases, in line with our findings in

Section IV.B.2. Taken together, these results provide evidence consistent with a substitution pattern, in which the growing importance of alternative sources of capital may be associated with a decline in bank debt.

Secondly, we perform a DiD analysis, in which we consider the post-treatment period to start 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 Table A9, maintain the expected signs (positive for ROA, negative for bank and long-term bank debt, and positive for the growth rate of equity funding) but are not statistically significant.

6. LLM as a Judge

We perform an additional robustness analysis, in which we collect the descriptions of these fintech firms' activity from the FinTech Radar and send them via API to GPT-4o, excluding the name of the company and all other information. We then use the prompt shown in Table A10, in which we essentially describe our identification strategy to ChatGPT. The idea is for the LLM to serve as an independent judge.

The LLM identifies 48 of the 50 treated firms as treated. The few false negatives correspond to borderline cases whose descriptions emphasize payment facilitation or merchant support tools without explicitly mentioning payment execution or account access. Manual verification confirms that these borderline firms are still subject to PSD2 obligations, validating the accuracy of our treated definition.

B. Subsample Analyses

To ensure that our findings are not driven by specific subsets of fintech firms, we perform a series of subsample analyses for our key outcomes: performance, bank debt, and alternative equity funding, reported in Tables A11 to A14. Each table focuses on one outcome variable, and each column corresponds to a different subsample restriction.

First, we restrict the sample to fintech–year observations that meet the Banco de España's Central Balance Sheet Data Office quality standards[28]. This ensures that our results are not affected by potential accounting misreporting. Column 1 in all tables shows that the results remain unchanged. Second, we extend the sample period to 2012–2022 to rule out biases linked to early fintech developments under PSD1. Column 2 shows that the estimates remain consistent. Third, we exclude 2020 to avoid distortions from COVID-19 shocks to performance, financing conditions, and investment. Column 3 confirms that the results are qualitatively similar. In Column 4, we restrict the sample to micro-firms (fewer than 10 employees) to verify that the results are not driven by the largest fintechs, a relevant test given that the average fintech employs seven workers. The main results hold. Column 5 limits the sample to firms classified under CNAE/NACE codes[29] (the Spanish and European industry classifications) corresponding to technological (M, N) or financial (K) activities. This serves as an additional filter to ensure that our sample effectively captures fintech firms and complements the Banco de España's FinTech Radar classification. The results remain qualitatively unchanged. Finally, Column 6 excludes firms located in major fintech clusters (Madrid, Barcelona, and Valencia) to ensure that our findings are not driven by

[28]The Central Balance Sheet Data Office of Banco de España 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.

[29]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.

location-specific advantages such as superior access to customers or funding. The estimates continue to hold.

Across all subsamples, the share of treated firms remains stable and comparable to the full sample (11.9%), confirming that the restrictions do not disproportionately alter the treatment–control composition and reinforcing the robustness of our results.

C. Dynamic DiD Specification

To examine the dynamic effects of PSD2, we augment the baseline specification by decomposing the post-treatment period into year-specific effects. Specifically, we replace the single interaction term Post-$PSD2_t$ × Payment $FinTech_i$ with a set of interactions between the treatment indicator and year dummies for each post-PSD2 year. This specification uses the same sample, controls, and fixed effects as the baseline model, differing only in that it allows the treatment effect to vary over time. By doing so, we can trace the year-by-year evolution of the effects and assess their statistical significance in each post-treatment period. Table A15 shows that the post-PSD2 effects persist over time.

The dynamic estimates also show that PSD2 effects did not fully materialize in 2018, but became clearer from 2019 onward. This timing is consistent with gradual adjustment: payment fintechs needed time to update infrastructure, comply with SCA and RTS requirements, integrate APIs, and translate access to payment-account data into commercial activity. A similar logic applies to funding. Investors may have waited to observe regulatory adaptation and market traction before increasing equity financing, and fintech funding rounds are discrete events linked to milestones rather than annual flows.

VII. Conclusion

Open banking enables customer-authorized access to financial data and reshapes competition in financial services. This paper examines how Europe’s open banking reform affects fintech firms. The PSD2 setting allows us to identify the fintech segment most directly exposed to the reform: payment services providers. We study the effects of open banking on fintech firm dynamics and funding using a difference-in-differences framework. To do so, we combine the Banco de España's FinTech Radar with firm-level balance-sheet and equity funding information to construct a panel of 423 Spanish fintech firms over the period 2014–2022.

Our results show relevant changes in both firm dynamics and financing. On average, treated firms exhibit a 24-percentage-point increase in ROA after the implementation of this open banking initiative compared to control fintech firms. Moreover, payment fintech firms invest less in intangible and tangible assets, prioritizing liquidity over long-term investments. These firms also exhibit reduced labor intensity but increased labor costs and an increased share of permanent employees, indicating a shift towards higher-skilled, more expensive labor. This change contributed to higher productivity among treated firms. In parallel, treated firms reduce their reliance on bank debt, especially long-term bank debt, and increase their reliance on equity funding, including larger and more stable equity funding among firms that secure external equity.

Evidence on mechanisms points to revenue growth and increased visibility for payment fintechs after PSD2, suggesting that access to customer data primarily strengthened revenue generation rather than reducing costs, while also attracting greater attention from both consumers and investors. Our results are robust to a range of checks, including tests of the identification strategy, anticipatory effects, random treatment assignments, and alternative sample specifications.

The Spanish setting features a relatively centralized open-banking infrastructure, where Redsys plays a central role as the primary API provider connecting banks and third-party providers (TPPs), facilitating interoperability and potentially contributing to uniform adoption patterns. Jurisdictions with multiple API providers may exhibit more fragmented competitive and technical dynamics. Future research could examine how the degree of centralization in open-banking infrastructures shapes the effects of data-access regulation across markets.

Although our analysis focuses on fintech firms, open banking regulations such as PSD2 affect a wide range of actors, including banks and credit institutions. Investigating the impact of open banking on them represents an important avenue for future research.

Overall, this paper contributes to the literature on open banking by providing empirical evidence on its effect on the dynamics of non-bank competitors, especially payment 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 inform decisions on how to regulate this increasingly important segment of the financial system.

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Table 1. 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 variables are defined in Table B1 of the Appendix.

VARIABLES	Observations	Mean	Median	St. Deviation	p25	p75	TREATED	CONTROL
CONTROL VARIABLES							**Mean: 2014–2022**	
Size	1922	6.33	6.33	1.94	5.06	7.69	5.94	6.38
Asset structure	1922	0.63	0.68	0.29	0.39	0.90	0.61	0.64
Solvency	1922	0.31	0.47	0.92	0.19	0.73	0.27	0.31
Efficiency	1922	0.06	0.06	1.13	-0.16	0.35	0.07	0.06
Liquidity	1922	6.07	1.99	17.8	1.05	4.27	4.80	6.23
Age	1922	7.51	5.00	6.94	3.00	10.00	6.75	7.61
MAIN DEPENDENT VARIABLES								
Performance							**Mean: 2014–2022**	
ROA	1922	-0.16	0.00	0.72	-0.19	0.09	-0.25	-0.15
ROE	1922	-0.03	0.04	1.88	-0.20	0.35	-0.13	-0.02
Operating ROA	1922	-0.14	0.00	0.68	-0.20	0.11	-0.23	-0.13
EBITDA ROA	1922	-0.10	0.03	0.67	-0.15	0.16	-0.16	-0.09
Ordinary Net Profits	1922	-0.17	0.00	2.26	-0.21	0.10	-0.31	-0.16
High-Profitable	1922	0.54	1.00	0.50	0.00	1.00	0.55	0.54
Traditional Debt Funding							**Mean: 2014–2022**	
Bank debt to liabilities	1879	0.17	0.01	0.27	0.00	0.28	0.14	0.18
Non-bank debt to liabilities	1896	0.25	0.01	0.33	0.00	0.50	0.29	0.25
Long-term bank debt to liabilities	1910	0.11	0.00	0.22	0.00	0.13	0.09	0.12
Short-term bank debt to liabilities	1868	0.06	0.00	0.12	0.00	0.06	0.05	0.06
Cost of funding	1742	0.05	0.01	0.17	0.00	0.04	0.03	0.05
Interest burden	1899	0.09	0.00	2.29	-0.01	0.03	-0.02	0.10
Alternative Equity Market Funding							**Mean: 2014–2022**	
Funding volume	1922	0.23	0.00	0.85	0.00	0.00	0.32	0.21
D_Funding volume	1922	0.07	0.00	0.26	0.00	0.00	0.06	0.07
ΔFunding_equity	1922	-0.01	0.00	0.39	0.00	0.00	-0.03	-0.00
SD_Funding volume	1922	0.07	0.00	0.25	0.00	0.00	0.08	0.07
#Investors	1922	0.37	0.00	1.02	0.00	0.00	0.41	0.36
First_Funding	1922	0.03	0.00	0.17	0.00	0.00	0.04	0.03
Funding_Frequency	1922	0.17	0.00	0.65	0.00	0.00	0.18	0.17
Investments, Labor & Productivity							**Mean: 2014–2022**	
Tangible assets (%)	1922	0.05	0.01	0.12	0.00	0.04	0.06	0.05
Intangible assets (%)	1922	0.23	0.10	0.27	0.00	0.40	0.30	0.22
Financial investments (%)	1922	0.08	0.00	0.17	0.00	0.05	0.04	0.08
Current assets (%)	1922	0.63	0.68	0.29	0.39	0.90	0.61	0.64
Growth #Employees	1536	0.78	0.13	2.45	-0.02	0.56	1.05	0.74
ΔEmployees to total assets	1922	-0.00	0.00	0.02	-0.00	0.00	0.00	-0.00
Cost of labor	1909	1.16	0.72	4.58	0.20	1.50	1.38	1.13
Productivity	1902	2.48	1.75	3.03	1.05	3.00	2.45	2.49

Table 2. 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 (Payment fintech firms) and control group firms (Non-payment fintech firms) for the four years before the implementation of PSD2. * Significant at 5%.

ΔROA	Treated	Control	Diff.	T-test
2014 (t-4)	0.015	0.004	0.011	0.066
2015 (t-3)	0.347	0.231	-0.228	-1.241
2016 (t-2)	-0.015	-0.020	-0.005	-0.045
2017 (t-1)	-0.072	0.011	0.084	0.580
ΔROE	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	-0.300	-0.014	0.286	0.433
2015 (t-3)	0.581	-0.133	-0.713	-1.197
2016 (t-2)	-0.227	0.028	0.256	0.573
2017 (t-1)	0.147	0.004	-0.143	-0.429
ΔBank debt (%liabilities)	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	0.020	0.020	-0.0005	-0.009
2015 (t-3)	0.040	0.007	-0.033	-0.556
2016 (t-2)	0.042	0.021	-0.021	-0.503
2017 (t-1)	-0.019	0.035	0.054	1.196
ΔFunding volume	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	0.009	0.009	0.0001	0.004
2015 (t-3)	0.000	0.052	0.052	0.861
2016 (t-2)	0.129	0.026	-0.103	-2.061*
2017 (t-1)	0.185	0.047	-0.138	1.929
ΔGrowth #Employees	**Treated**	**Control**	**Diff.**	**T-test**
2014 (t-4)	-0.943	-0.363	0.580	1.082
2015 (t-3)	0.193	-0.645	-0.838	-0.956
2016 (t-2)	-1.322	-0.819	0.504	0.613
2017 (t-1)	0.524	-0.325	-0.849	-1.628

Table 3. Results on Performance and Growth Dynamics

This table presents the results of the difference-in-differences regressions on fintech firms' performance and growth dynamics. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	Performance						Growth dynamics	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Dependent variables	**ROA**	**ROE**	**Op. ROA**	**EBITDA ROA**	**Ordinary net Profits**	**High-Profit**	**ΔAssets**	**△Capital**
Post-PSD2 x Payment FinTech	0.240***	-0.223	0.200**	0.202***	0.345**	0.186*	-0.317	2.137*
	(0.081)	(0.222)	(0.082)	(0.077)	(0.172)	(0.100)	(1.228)	(1.204)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,922	1,922	1,922	1,922	1,922	1,922	1,922	1,925
R-squared	0.427	0.240	0.455	0.453	0.213	0.271	0.421	0.211
Number of firms	423	423	423	423	423	423	423	422

Table 4. Results on Firms' Investments, Labor Intensity, and Productivity

This table presents the results of the difference-in-differences regressions on firms' investments, liquidity, employment 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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	Employment			Productivity
	1	2	3	4	5	6	7	8
Dependent variable	**%Tangible assets**	**%Intangible assets**	**%Financial inv.**	**%Current assets**	**Δ#Employees**	**Labor costs**	**%Permanent employees**	**Productivity**
Post-PSD2 x Payment FinTech	0.001	-0.073**	-0.024*	0.093***	-1.107*	0.982**	0.490*	0.822*
	(0.017)	(0.036)	(0.014)	(0.035)	(0.569)	(0.391)	(0.299)	(0.454)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,922	1,922	1,922	1,922	1,536	1,909	805	1,902
R-squared	0.777	0.794	0.727	0.765	0.398	0.273	0.667	0.567
Number of firms	423	423	423	423	357	423	240	423

Table 5. Results on Traditional Debt Funding: Bank Debt vs. Non-bank Debt

This table presents the results of the difference-in-differences regressions on fintech firms' traditional debt 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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		Maturity: Bank debt		Maturity: Non-bank debt		Cost of debt & interest burden	
	1	2	3	4	5	6	7	8	9	10
Dependent variable	Bank debt_liab	Bank debt_assets	Nonbank debt_liab	Nonbank debt_assets	LT bank debt_liab	ST bank debt_liab	LT nonbank debt_liab	ST nonbank debt_liab	Debt costs	Interest burden
Post-PSD2 x Payment FinTech	-0.109**	-0.090**	0.058	0.024	-0.082**	-0.025	0.013	0.047*	0.012	-0.258*
	(0.052)	(0.040)	(0.047)	(0.083)	(0.038)	(0.031)	(0.047)	(0.028)	(0.025)	(0.147)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,879	1,891	1,896	1,908	1,910	1,868	1,910	1,910	1,478	1,617
R-squared	0.613	0.578	0.648	0.666	0.578	0.554	0.664	0.599	0.289	0.170
Number of firms	420	420	423	423	423	420	423	423	387	404

Table 6. Alternative Equity Market Funding

This table presents the results of the difference-in-differences regression on alternative equity 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

				Subsample: Alternative equity market funding=1				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Dependent variables	**Funding volume**	**Funding volume**	**ΔFunding_equity**	**Funding volume**	**SD Funding**	**#Investors**	**First_Funding**	**Funding_Interval**
Post-PSD2 x Payment FinTech	-0.091	-0.084	0.068**	1.097**	-0.915***	3.345***	0.436**	-1.484***
	(0.067)	(0.061)	(0.033)	(0.534)	(0.143)	(0.839)	(0.176)	(0.500)
Post-PSD2 x Payment FinTech x 1st Round		0.933**						
		(0.361)						
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,929	1,929	1,929	137	137	137	137	137
R-squared	0.741	0.745	0.182	0.741	0.837	0.614	0.781	0.689
Number of firms	423	423	423	74	74	74	74	74

Table 7. Alternative Equity Market Funding: Equity vs. Bank Funding

This table presents the results of the difference-in-differences regression on alternative equity 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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_liab		LT Bank debt_liab	
Dependent variables	**1**	**2**	**3**	**4**
Amount Funding	-0.0005**	-0.0005**	-0.0005	-0.0005
	(0.000)	(0.000)	(0.000)	(0.000)
Post-PSD2 x Payment FinTech	-0.109**	-0.108**	-0.081**	-0.080**
	(0.052)	(0.052)	(0.038)	(0.038)
Post-PSD2 x Payment FinTech x Amount Funding		-0.004**		-0.004**
		(0.002)		(0.001)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,879	1,879	1,910	1,910
R-squared	0.613	0.613	0.578	0.578
Number of firms	420	420	423	423

Table 8. Alternative Equity Market Funding: Venture Capital Funding Stages

This table presents the results of the difference-in-differences regression on different stages of venture capital investment: early-stage VC, late-stage VC, and growth equity VC for the subsample of fintech firms that obtain equity funding in a given year. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	Early-stage VC	Late-stage VC	Growth equity VC
Dependent variables	**1**	**2**	**3**
Post-PSD2 x Payment FinTech	-0.379**	1.018***	-0.106
	(0.161)	(0.031)	(0.099)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Observations	137	137	137
R-squared	0.870	0.813	0.583
Number of firms	74	74	74

Table 9. Potential Mechanisms

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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	△Revenues	**△Costs**	**Investors and Consumers' attention**	**Internal Growth**
	1	**2**	**3**	**4**
Dependent variables	**△Output value**	**△Op. costs**	**Google Trends**	**△Retained earnings**
Post-PSD2 x Payment FinTech	2.275*	-4.161	4.252*	-10.627
	(1.203)	(4.187)	(2.522)	(6.685)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,758	1,915	1,929	1,920
R-squared	0.333	0.330	0.743	0.295
Number of firms	392	422	423	421

The Effects of Open Banking on FinTech Firms' Dynamics and Funding Structure

INTERNET APPENDIX

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This internet appendix contains additional information. Note that JFQA uses the term Supplementary Material for this content.

APPENDIX A

Table A1. 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	Fintechs in FinTech Radar with data in CBI
Non-Payment fintech	671 (84.5%)	373 (88.1%)
Payment fintech	123 (15.6%)	50 (11.9%)
Total	**794**	**423**

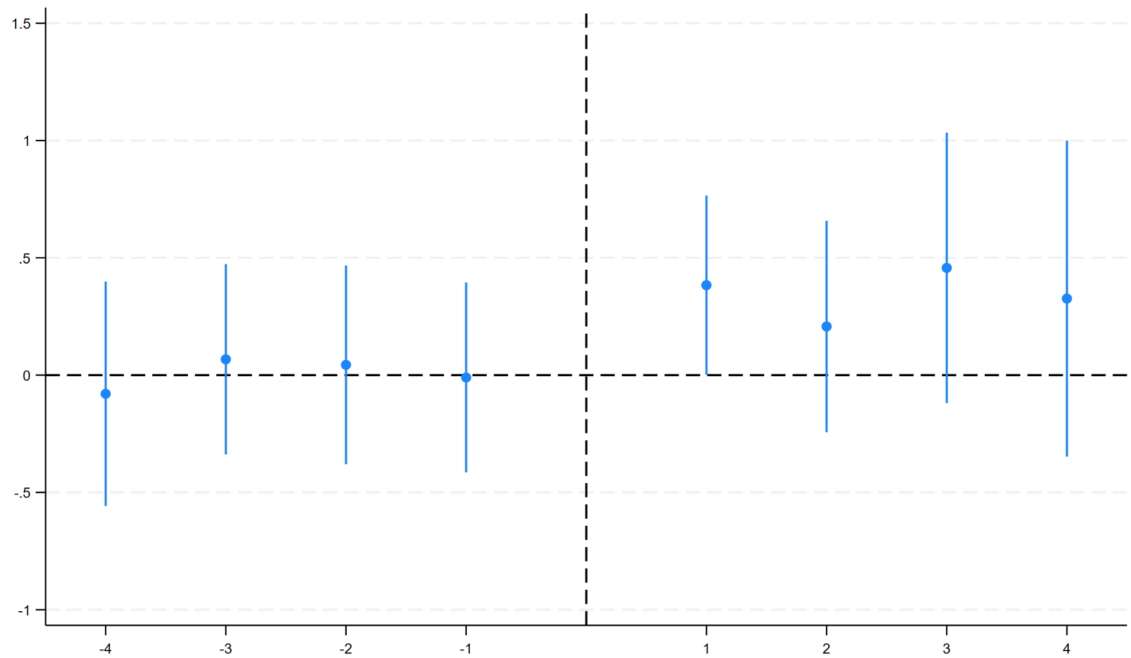
Table A2. Number of treated and control firms per year

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	224	21	8.57%

Figures A1: Dynamic DiD results (Parallel trends) on performance

A1a. ROA: This figure plots the coefficient values and 90 % confidence interval for the dynamic DiD results of the coefficients on *Payment FinTech* × *Year* dummies on returns on assets (ROA) over time for periods from t = −4 to t = t + 4 around the implementation of the PSD2.



A1b. Operating ROA: This figure plots the coefficient values and 90 % confidence interval for the dynamic DiD results of the coefficients on *Payment FinTech* × *Year* dummies on Operating ROA (Operating ROA) over time for periods from t = −4 to t = t + 4 around the implementation of the PSD2.

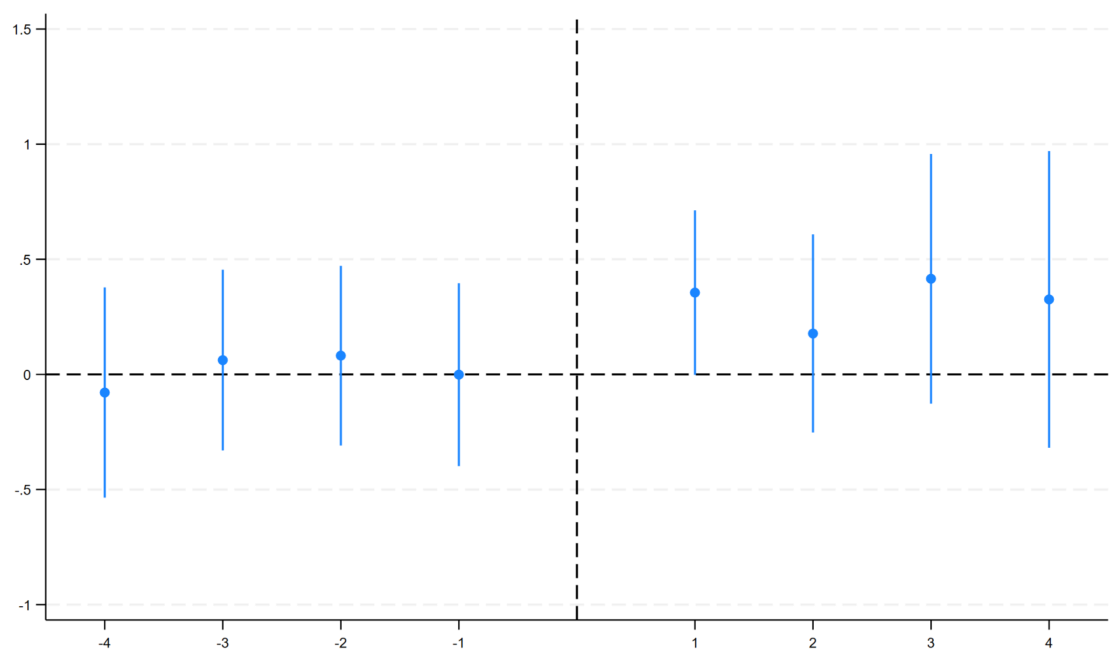
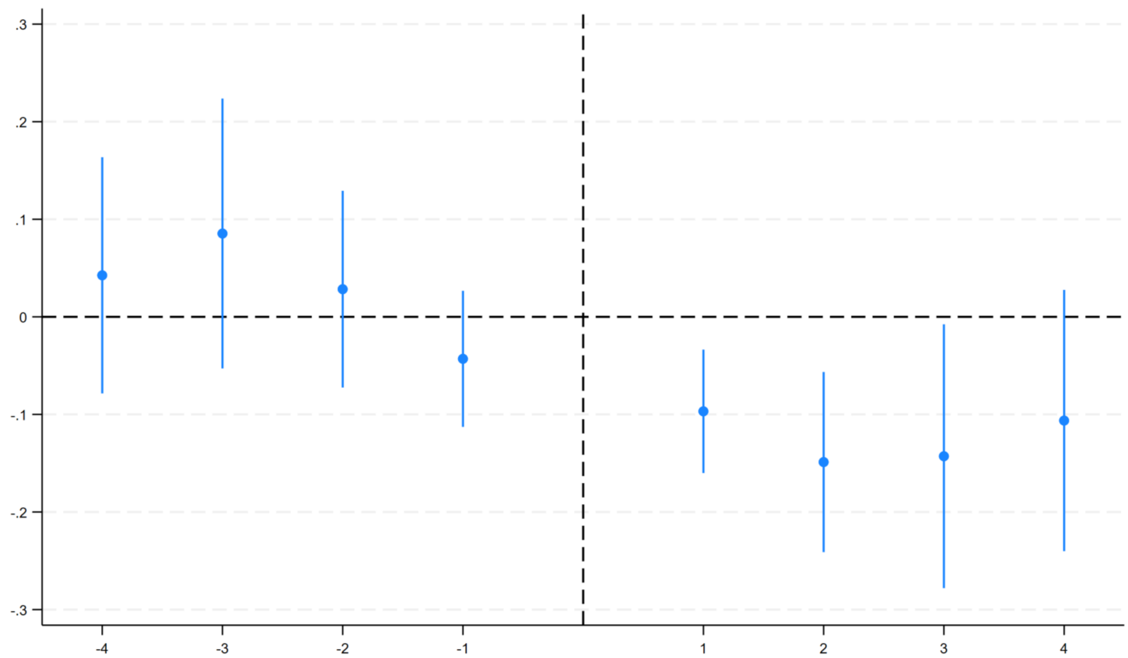


Figure A2: Dynamic DiD results (Parallel trends) on traditional debt funding

Graph A2a. Bank debt over total liabilities: This figure plots the coefficient values and 90 % confidence interval for the dynamic DiD results of the coefficients on *Payment FinTech* × *Year* dummies on bank debt over total liabilities over time for periods from t = −4 to t = t + 4 around the implementation of the PSD2.



Graph A2b. Long-term bank debt over total liabilities: This figure plots the coefficient values and 90 % confidence interval for the dynamic DiD results of the coefficients on *Payment FinTech* × *Year* dummies on bank debt over total liabilities over time for periods from t = −4 to t = t + 4 around the implementation of the PSD2.

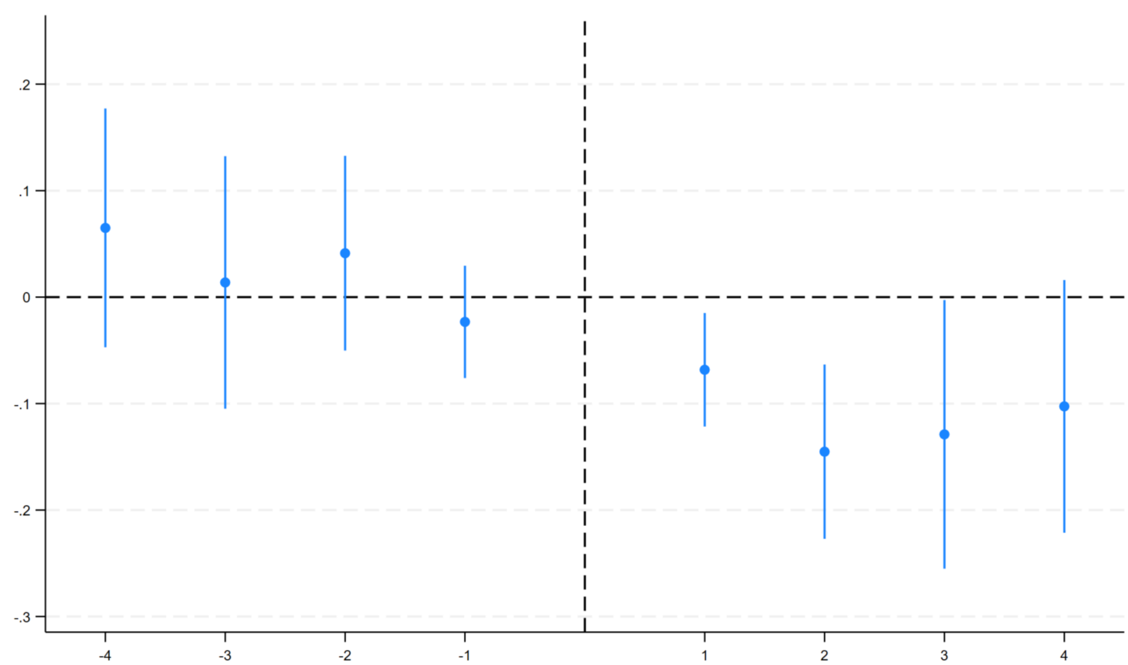
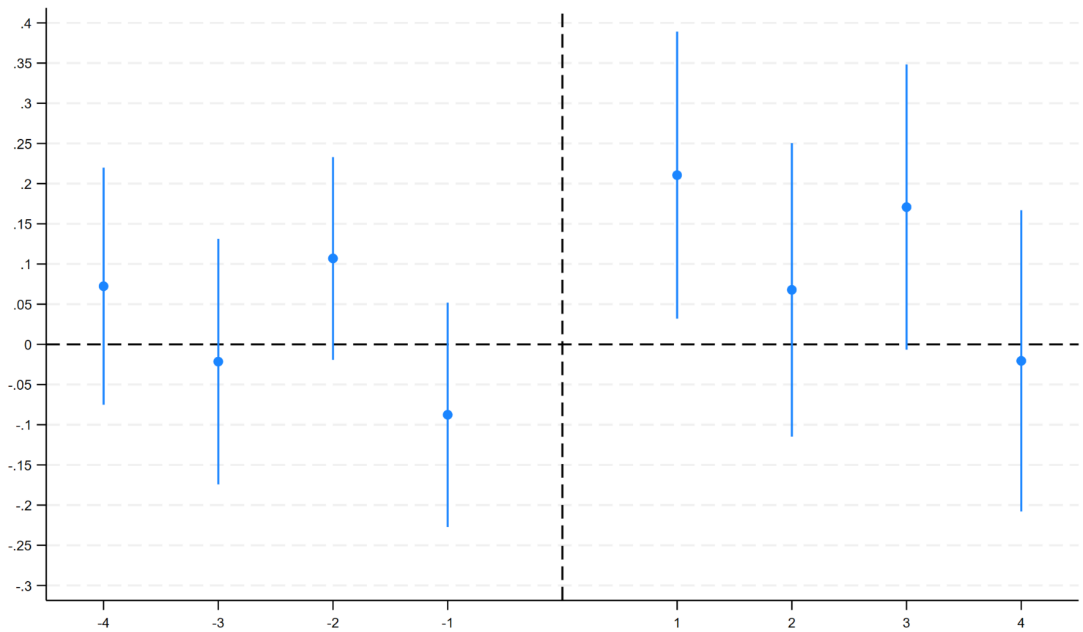


Figure A3: Dynamic DiD results (Parallel trends) on alternative equity market funding

Graph A3a. Growth rate of equity funding (ΔFunding_equity$_{,i,[t-3,t]]}$): This figure plots the coefficient values and 90 % confidence interval for the dynamic DiD results of the coefficients on *Payment FinTech* × *Year* dummies on the growth rate of equity funding over time for periods from t = −4 to t = t + 4 around the implementation of the PSD2.



Graph A3b. Alternative equity market funding volume (Funding volume$_{,i,[t-3,t]]}$): This figure plots the coefficient values and 90 % confidence interval for the dynamic DiD results of the coefficients on *Payment FinTech* × *Year* dummies on alternative equity market funding volume over time for periods from t = −4 to t = t + 4 around the implementation of the PSD2.

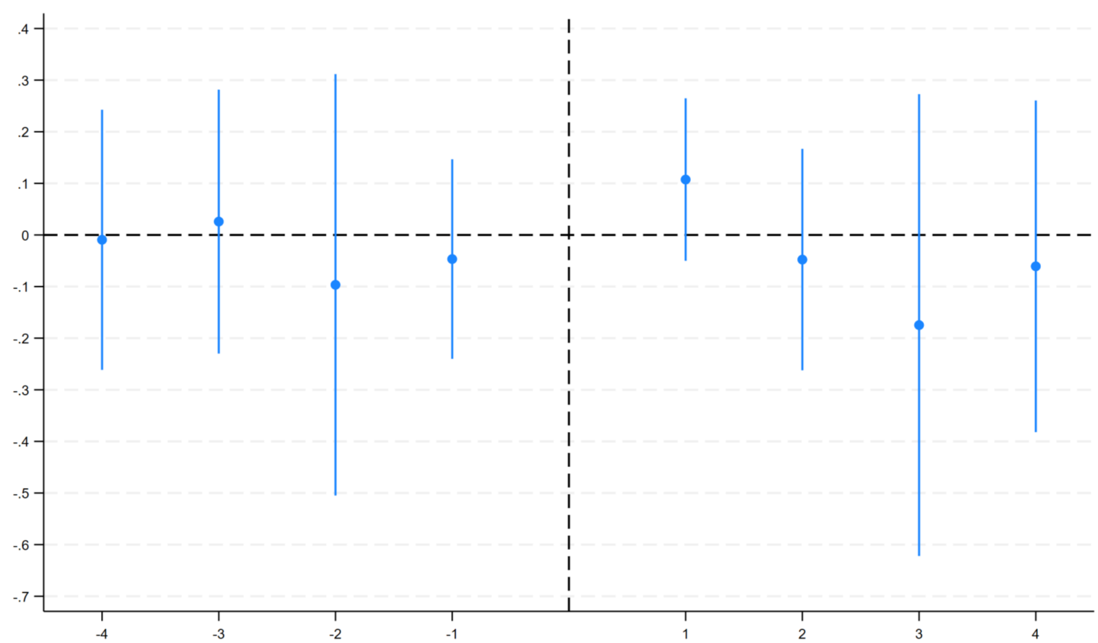


Table A3. Heterogeneous effect on performance (ROA)

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), and age (Column 3). The interaction term, Post-PSD2 x Payment FinTech x Variable, is the DiD term that reflects the heterogeneous effect on performance. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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**	**Age**
	1	**2**	**3**
Post-PSD2 x Payment FinTech	0.756**	0.273***	0.232*
	(0.312)	(0.081)	(0.134)
Variable	0.030	-0.143*	-0.009
	(0.026)	(0.081)	(0.012)
Post-PSD2 x Payment FinTech x Variable	-0.083	-0.136	0.001
	(0.053)	(0.096)	(0.007)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Observations	1,922	1,922	1,922
R-squared	0.429	0.429	0.427
Number of firms	423	423	423

Table A4. Heterogeneous effect on 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), and age (Column 3). The interaction term, Post-PSD2 x Payment FinTech x Variable, is the DiD term that reflects the heterogeneous effect on bank debt. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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**	**Age**
	1	**2**	**3**
Post-PSD2 x Payment FinTech	-0.094	-0.113**	-0.068
	(0.073)	(0.052)	(0.066)
Variable	0.014	0.002	-0.003
	(0.009)	(0.008)	(0.004)
Post-PSD2 x Payment FinTech x Variable	-0.002	0.016	-0.004
	(0.010)	(0.025)	(0.006)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Observations	1,879	1,879	1,879
R-squared	0.613	0.613	0.613
Number of firms	420	420	420

Figure A4. Alternative funding to payment fintechs (% of Total, Europe ex-UK)
The figure shows the share of alternative funding received by payment fintech providers over the total fintech sector funding in Europe (excluding the UK), between 2015 and 2022. The vertical line in 2018 marks the adoption of the open banking framework in Europe.

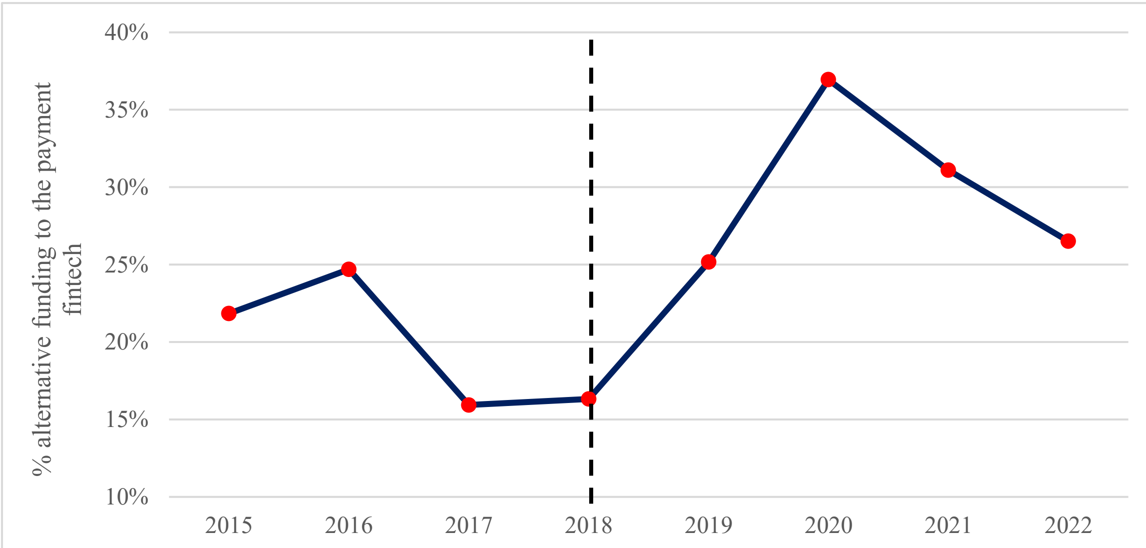


Table A5. Investor composition in alternative equity market funding
This table presents the results of the difference-in-differences regressions on the composition of investors in alternative equity funding rounds. The dependent variables capture whether a funding round involved a bank investor (Columns 1 and 3) or a non-EU investor (columns 2 and 4). Columns (1) and (2) report results for the full sample of fintech firms, while Columns (3) and (4) restrict the analysis to the subsample of equity-funded fintechs. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

			Subsample: Alternative equity market funding=1	
Dependent variables	**Bank investor**	**Non-EU investor**	**Bank investor**	**Non-EU investor**
	1	**2**	**3**	**4**
Post-PSD2 x Payment FinTech	0.0005	0.029	0.039	1.050***
	(0.004)	(0.025)	(0.085)	(0.204)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,929	1,929	137	137
R-squared	0.295	0.432	0.645	0.727
Number of firms	423	423	74	74

Table A6. Additional analysis: Licensed payment fintech vs Non-payment fintech

This table presents the results of the robustness checks. In this regression, we consider only licensed payment fintechs as treated, while the rest of the non-payment fintechs are in the control group. The interaction term Post-PSD2 x Payment FinTech takes the value 1 if the year is equal to or after 2018 and the fintech is treated. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	Licensed payment fintech (treated) vs Non-payment fintech (control)			
	1	**2**	**3**	**4**
Dependent variables	**ROA**	**Bank debt**	**LT Bank debt**	**ΔEquity funding**
Post-PSD2 x Payment FinTech	0.332*	-0.060*	-0.047*	0.106*
	(0.197)	(0.033)	(0.028)	(0.064)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,764	1,727	1,754	1,770
R-squared	0,424	0,615	0,570	0,183
Number of firms	387	385	387	387

Table A7. Additional analysis: Non-licensed payment fintech vs Non-payment fintech

This table presents the results of the robustness checks. In this regression, we consider only non-licensed payment fintechs as treated, while the rest of the non-payment fintechs are in the control group. The interaction term Post-PSD2 x Payment FinTech takes the value 1 if the year is equal to or after 2018 and the fintech is treated. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	Non-licensed payment fintech (treated) vs Non-payment fintech (control)			
	1	**2**	**3**	**4**
Dependent variables	**ROA**	**Bank debt**	**LT Bank debt**	**ΔEquity funding**
Post-PSD2 x Payment FinTech	0.197***	-0.122*	-0.090*	0.085*
	(0.067)	(0.063)	(0.046)	(0.049)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,868	1,828	1,857	1,875
R-squared	0,426	0,612	0,578	0,245
Number of firms	409	406	409	409

Table A8. Robustness check: excluding robo-advisors and asset managers from the control group

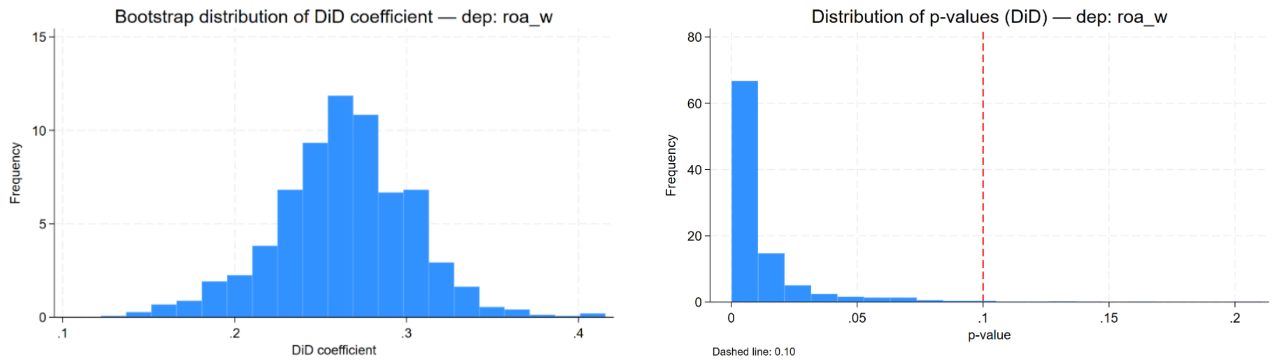
This table presents the results of the robustness checks excluding robo-advisors and asset managers from the control group. The interaction term Post-PSD2 x Payment FinTech takes the value 1 if the year is equal to or after 2018 and the fintech is treated. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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

	1	2	3	4
Dependent variables	**ROA**	**Bank debt**	**Long-term Bank debt**	**ΔFunding_equity**
Post-PSD2 x Payment FinTech	0.253***	-0.109**	-0.083**	0.067**
	(0.077)	(0.052)	(0.038)	(0.034)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,868	1,825	1,856	1,897
R-squared	0.409	0.601	0.573	0.185
Number of firms	408	405	408	408

Figure A5: Resampling the control group

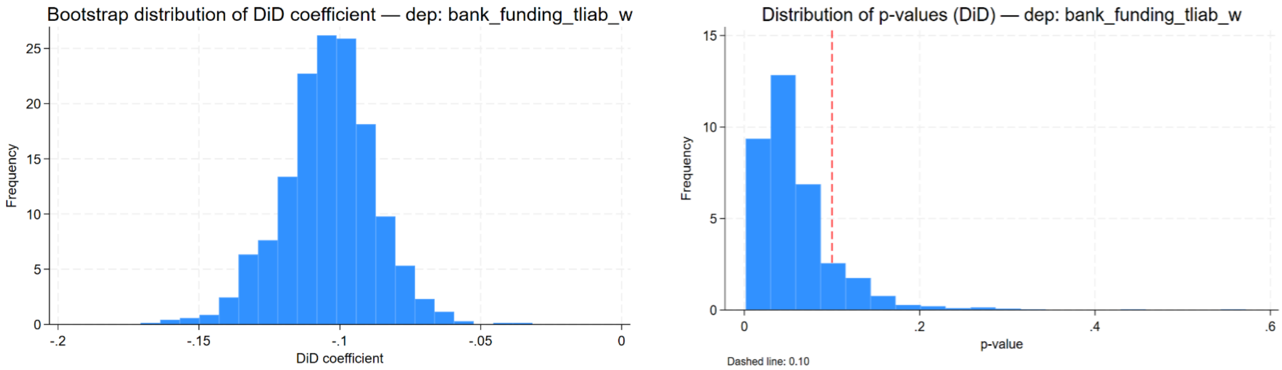
Graph A5a. Distribution of the estimated coefficients and p-values for ROA

These figures show the distribution of DiD coefficient estimates and their associated p-values for ROA across 1,000 placebo regressions. In each iteration, the set of treated firms is held fixed, while a random subset of 150 to 350 control firms is drawn from the pool of non-treated fintechs.



Graph A5b. Distribution of the estimated coefficients and p-values for Bank debt over total liabilities

These figures show the distribution of DiD coefficient estimates and their associated p-values for bank debt across 1,000 placebo regressions. In each iteration, the set of treated firms is held fixed, while a random subset of 150 to 350 control firms is drawn from the pool of non-treated fintechs.



Graph A5c. Distribution of the estimated coefficients and p-values for the Growth rate of equity funding

These figures show the distribution of DiD coefficient estimates and their associated p-values for the Growth rate of equity funding across 1,000 placebo regressions. In each iteration, the set of treated firms is held fixed, while a random subset of 150 to 350 control firms is drawn from the pool of non-treated fintechs.

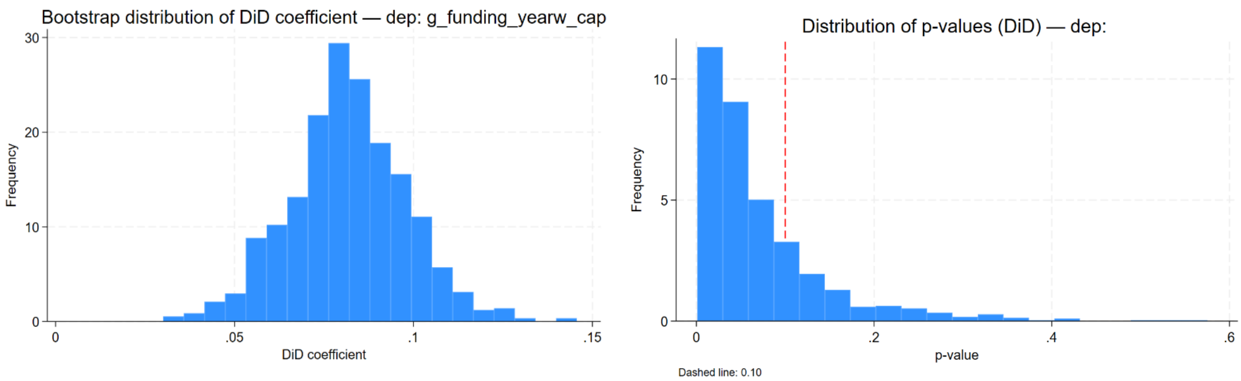
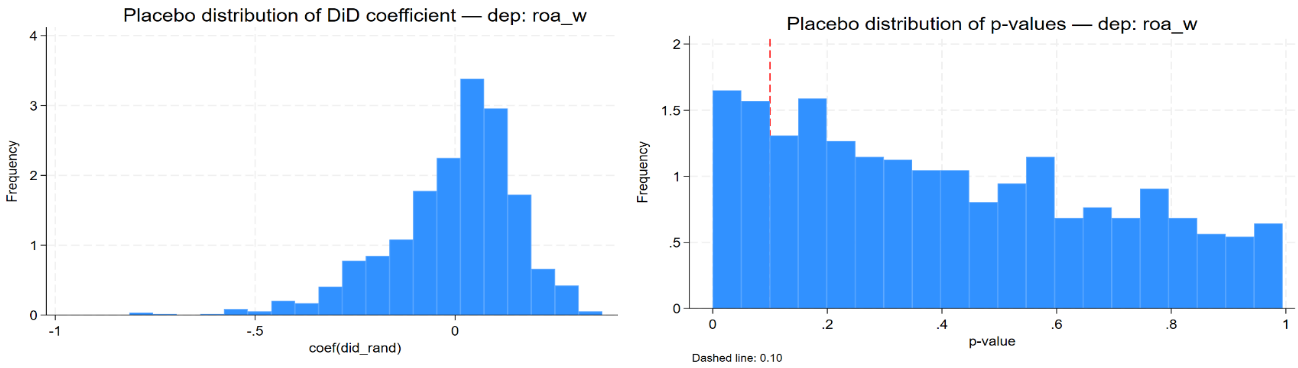


Figure A6: Placebo test with random treatment assignment

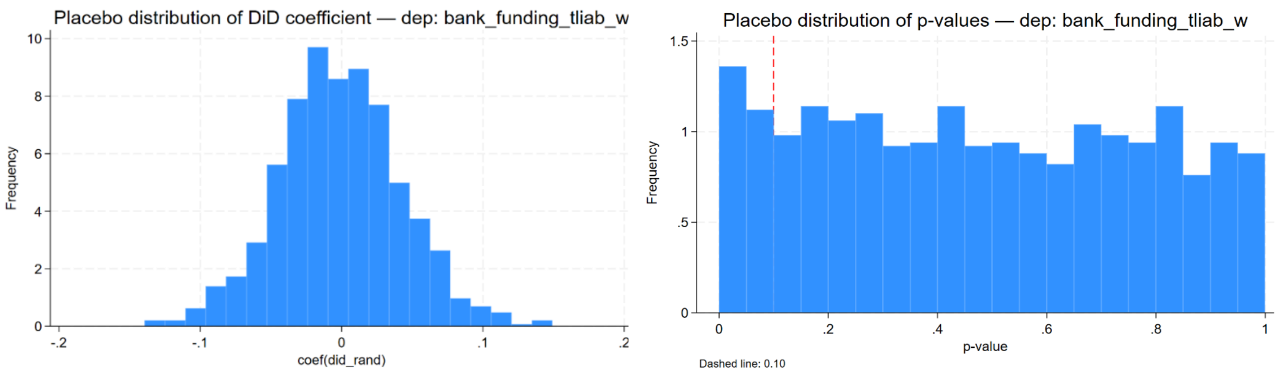
Graph A6a. Histograms of the estimated coefficients and corresponding p-values for the placebo experiment for ROA

These figures show the histograms of the estimated coefficients and corresponding p-values from a placebo experiment in which, for each of 1,000 iterations, a random subset of firms equal to the size of the actual treated group is assigned to treatment.



Graph A6b. Histograms of the estimated coefficients and corresponding p-values for the placebo experiment for Bank debt over total liabilities

These figures show the histograms of the estimated coefficients and corresponding p-values from a placebo experiment in which, for each of 1,000 iterations, a random subset of firms equal to the size of the actual treated group is assigned to treatment.



Graph A6c. Histograms of the estimated coefficients and corresponding p-values for the placebo experiment for the Growth rate of equity funding

These figures show the histograms of the estimated coefficients and corresponding p-values from a placebo experiment in which, for each of 1,000 iterations, a random subset of firms equal to the size of the actual treated group is assigned to treatment.

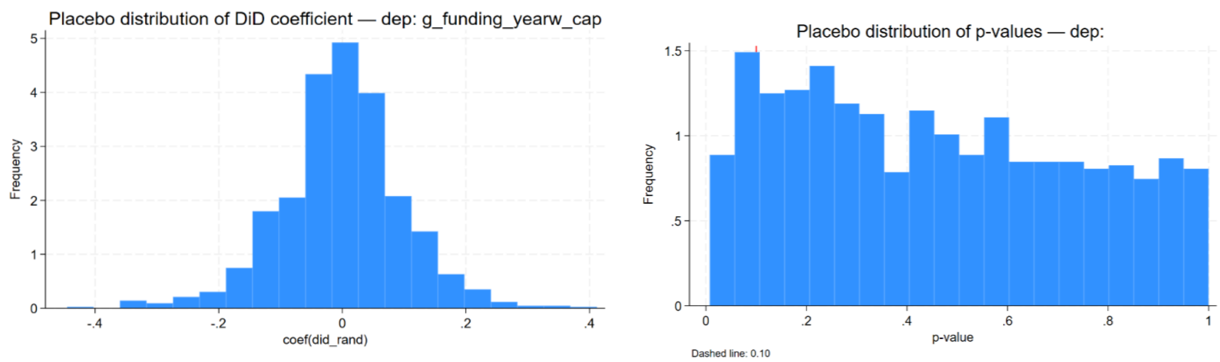
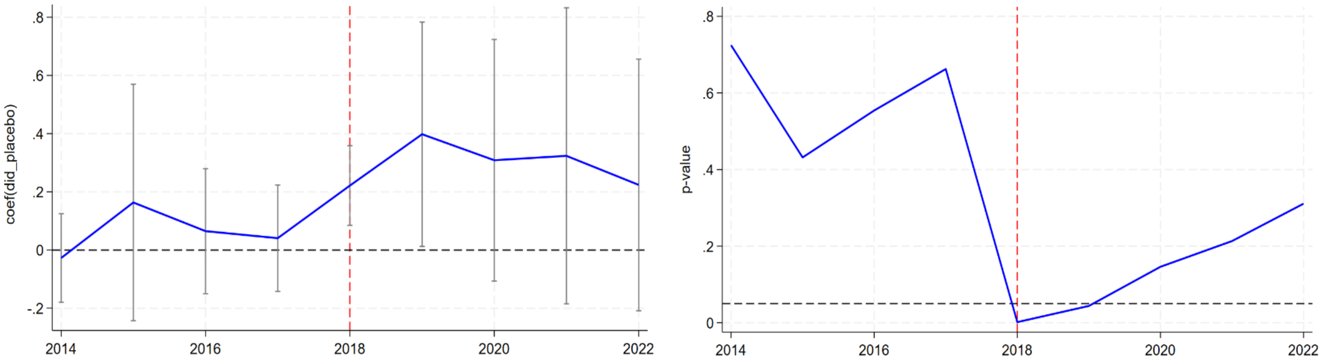


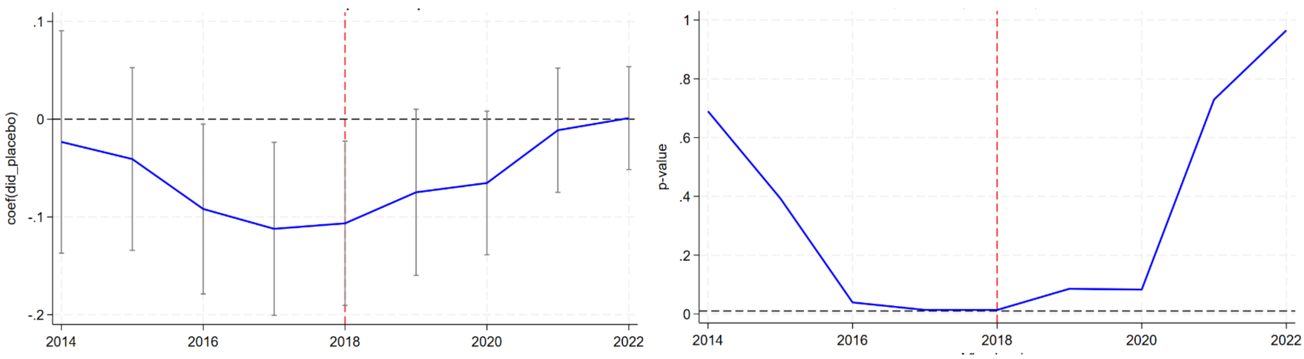
Figure A7: Placebo test shifting the treatment year

These figures show, for each placebo treatment year between 2014 and 2022, the estimated DiD coefficient (left panel) and the corresponding p-value (right panel). In each case, the treatment year is artificially reassigned, and the model is re-estimated using the available observations within up to four years before and after each placebo treatment year, constrained by the sample period, allowing us to assess whether the observed effects could be driven by pre-existing dynamics or unrelated trends.

Graph A7a. Estimated DiD coefficient (left panel) and the corresponding p-value (right panel) for ROA



Graph A7b. Estimated DiD coefficient (left panel) and the corresponding p-value (right panel) for bank debt



Graph A7c. Estimated DiD coefficient (left panel) and the corresponding p-value (right panel) for the growth rate of equity debt

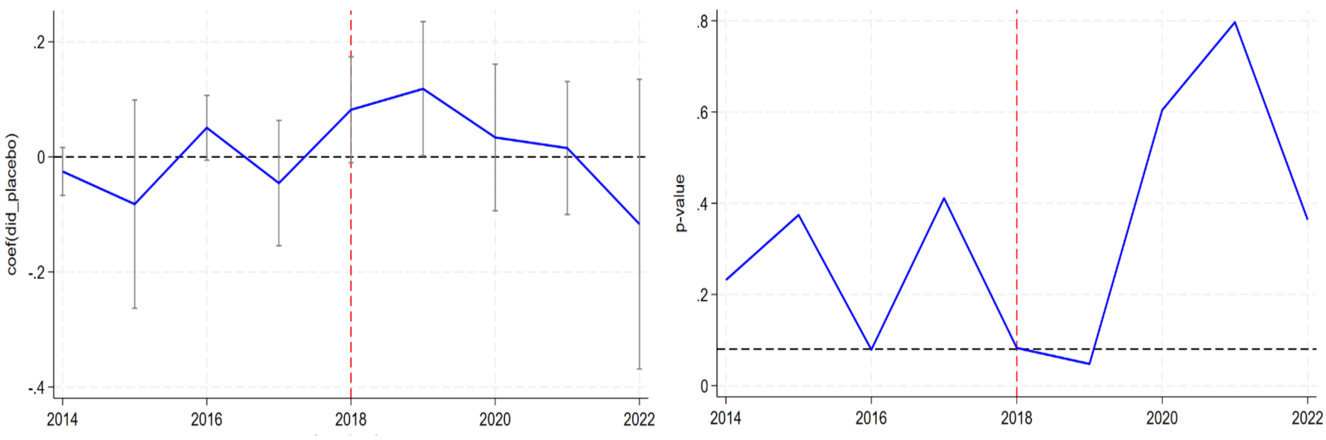


Table A9. Robustness: Anticipation effects

This table presents the results of the robustness checks. 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. 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
.

	1	**2**	**3**
Dependent variables	**ROA**	**Bank debt**	**ΔEquity funding**
Post-PSD2 x Payment FinTech	0.059	-0.089	0.008
	(0.105)	(0.057)	(0.025)
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Observations	1,394	1,358	1,385
R-squared	0,435	0,663	0,165
Number of firms	340	338	340

Table A10. ChatGPT Prompt

This table shows the prompt used in GPT-4o to classify the treated firms

"You are a regulatory expert specializing in financial innovation and European regulation. Your task is to classify fintech companies as treated ("treated") or not treated ("control") in a study on the impact of the PSD2 directive (open banking).

PSD2 introduced:

1. The possibility for third parties to access customers' bank accounts and make payments on their behalf. 2. New regulatory requirements such as strong customer authentication (SCA) and regulatory technical standards (RTS), which affected firms that process payments directly or access payment accounts.

A company must be classified as "treated" **only if its primary activity**:

- Involves the direct processing of payments on behalf of customers, or

- Requires accessing customers' payment accounts (not merely checking prices, markets, or offering advisory services), or

- Is required to comply with PSD2 via APIs, SCA, or RTS due to its role as a payment service provider.

Classify as "control" if the company:

- Does not process payments,

- Does not access customers' bank accounts,

- Does not need to meet PSD2 technical or regulatory requirements to operate.

Evaluate this description: "{description}":

Table A11. 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 6.2. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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	0.228***	0.206**	0.245***	0.243***	0.286***	0.216**
	(0.071)	(0.082)	(0.093)	(0.090)	(0.099)	(0.095)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,265	2,066	1,655	1,651	1,646	510
R-squared	0.472	0.404	0.453	0.384	0.437	0.406
Number of firms	379	426	412	402	372	111
% treated in subsample	10.90%	10.99%	11.06%	11.57%	11.60%	12.15%

Table A12. 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 6.2. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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	-0.169**	-0.116**	-0.113**	-0.136**	-0.113**	-0.315***
	(0.070)	(0.051)	(0.055)	(0.059)	(0.052)	(0.098)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,232	2,086	1,618	1,612	1,607	501
R-squared	0.654	0.595	0.621	0.617	0.607	0.615
Number of firms	377	423	410	398	368	109
% treated in subsample	10.79%	10.78%	10.94%	11.29%	11.32%	11.97%

Table A13. 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 6.2. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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: LT 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	-0.137**	-0.078*	-0.086**	-0.101**	-0.077**	-0.212***
	(0.055)	(0.038)	(0.041)	(0.043)	(0.035)	(0.079)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,259	2,120	1,645	1,639	1,634	506
R-squared	0.633	0.573	0.583	0.587	0.566	0.641
Number of firms	379	426	412	401	371	111
% Treated in subsample	10.88%	10.89%	11.00%	11.47%	11.51%	12.05%

Table A14. Robustness: Subsample analyses on the growth rate of equity funding

This table presents the results of the robustness checks. The dependent variable is the growth rate of equity funding. The analyses are described in Section 6.2. 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 regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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: ΔEquity funding					
	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	0.088*	0.054*	0.069**	0.064	0.098**	0.041
	(0.049)	(0.031)	(0.035)	(0.041)	(0.046)	(0.041)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,265	2,145	1,662	1,658	1,653	510
R-squared	0.215	0.180	0.245	0.192	0.185	0.084
Number of firms	379	426	412	402	372	111
% Treated in subsample	10.90%	11.00%	11.07%	11.58%	11.61%	12.16%

Table A15. Dynamic DiD

This table presents the results of difference-in-differences regressions on fintech firms' performance and funding outcomes. The interaction terms are Payment FinTech × Post-PSD2$_k$, where Post-PSD2$_k$ is an indicator variable equal to one if year t corresponds to the k-th year after the implementation of PSD2 (with k = 1 for 2018, k = 2 for 2019, and so on), and zero otherwise. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	1	**2**	**3**	**4**
Dependent variables	**ROA**	**Bank debt**	**Long-term bank debt**	**ΔFunding_equity**
Post-PSD2$_{1\ (2018)}$ x Payment FinTech	0.109	-0.076*	-0.045*	-0.007
	(0.203)	(0.045)	(0.033)	(0.051)
Post-PSD2$_{2\ (2019)}$ x Payment FinTech	0.321**	-0.104**	-0.067*	0.106*
	(0.129)	(0.052)	(0.037)	(0.060)
Post-PSD2$_{3\ (2020)}$ x Payment FinTech	0.084	-0.129***	-0.105***	0.081
	(0.214)	(0.058)	(0.044)	(0.060)
Post-PSD2$_{4\ (2021)}$ x Payment FinTech	0.394***	-0.128	-0.103	0.171**
	(0.142)	(0.083)	(0.069)	(0.039)
Post-PSD2$_{5\ (2022)}$ x Payment FinTech	0.415**	-0.138*	-0.127*	0.026
	(0.194)	(0.085)	(0.067)	(0.082)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,922	1,879	1,910	1,929
R-squared	0.429	0.613	0.579	0.184
Number of firms	423	420	423	423
Unweighted average of coefficients: Post-PSD2$_i$ x Payment FinTech	0.264	-0.115	-0.089	0.075
Coefficient DiD regression: Post-PSD2$_i$ x Payment FinTech	0.240	-0.109	-0.082	0.068

Table A16. Additional analysis: lending and mortgage intermediaries fintechs as controls

This table presents the results of the robustness checks considering lending and mortgage intermediaries fintechs in the control group. The interaction term Post-PSD2 x Payment FinTech takes the value 1 if the year is equal to or after 2018 and the fintech is treated. All regressions include controls for firm size, asset structure, solvency, efficiency, liquidity, and firm age. All variables are defined in Table B1 of the Appendix. 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.

	1	2	3	4
Dependent variables	**ROA**	**Bank debt**	**LT Bank debt**	**ΔEquity funding**
Post-PSD2 x Payment FinTech	0.261***	-0.111**	-0.082**	0.069**
	(0.082)	(0.052)	(0.038)	(0.034)
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	1,969	1,924	1,956	1,770
R-squared	0.426	0.615	0.580	0.191
Number of firms	439	436	439	439

APPENDIX B

Table B.1. Definition of variables

Variable	Definition
Performance	
ROA	Return on assets at the end of year t
ROE	Return on equity at the end of year t
△Assets	Annual growth rate of firms' assets
△Capital	Annual growth rate of firms' capital
Op. ROA	EBIT to total assets at the end of year t
EBITDA ROA	EBITDA to total assets at the end of year t
Ordinary Net Profits	Ordinary net profits to total assets at the end of year t
High-Profit	Dummy variable taking the value 1 if profits at the end of year t exceeded the average profits of the preceding three years
Traditional debt funding	
Bank debt_assets	Ratio of total bank debt (long-term and short-term) to total assets at the end of year t
Bank debt_liab	Ratio of total bank debt (long-term and short-term) to total liabilities at the end of year t
Nonbank debt_assets	Ratio of total non-bank debt (long-term and short-term) to total assets at the end of year t
Nonbank debt_liab	Ratio of total non-bank debt (long-term and short-term) to total liabilities at the end of year t
LT bank debt_liab	Ratio of total long-term bank debt to total liabilities at the end of year t
ST bank debt_liab	Ratio of total short-term bank debt to total liabilities at the end of year t
Debt cost	Ratio of interests on borrowed funds to total debt (bank and non-bank) at the end of year t
Interest burden	Ratio of interests on borrowed funds to the sum of gross operating profit and financial revenue at the end of year t
Alternative equity market funding	
Funding volume	Cumulative alternative equity funding volume from year t-3 to year t
ΔFunding_equity	Symmetric growth rate $(\frac{x_t - x_{t-1}}{x_t + x_{t-1}})$ of the cumulative funding over firm's equity
SD_Funding	Standard deviation of the cumulative alternative equity funding obtained from year t-3 to year t
#Investors	Total number of investors that invested in the firm i at year t
First_Funding	Dummy variable equal to one if firm *i* receives alternative equity funding for the first time in year t
Funding_Interval	Natural logarithm of the number of months since the last equity funding round
Early-stage VC	Dummy variable equal to one if firm i receives early-stage venture capital funding in year t
Late-stage VC	Dummy variable equal to one if firm i receives late-stage venture capital funding in year t
Growth equity VC	Dummy variable equal to one if firm i receives growth equity venture capital funding in year t
Bank investor	Dummy variable equal to one if at least one investor participating in a funding round of fintech firm i in year t is a bank
Non-EU investor	Dummy variable equal to one if at least one investor in firm i's funding round in year t is headquartered outside the European Union
Real economic outcomes	
%Tangible assets	Ratio of tangible assets to total assets at the end of year t
%Intangible assets	Ratio of intangible assets to total assets at the end of year t
%Financial inv.	Ratio of investments on financial assets to total assets at the end of year t
%Current assets	Ratio of current assets to total assets at the end of year t
Δ #Employees	Annual growth rate of the number of employees
Labor costs	Ratio of total labor costs (wages + social security costs) to total operating costs

%Permanent employees	Natural logarithm of the ratio of permanent employees to temporary employees at the end of year t
Productivity	Ratio of output value of production to the value of total inputs
Controls	
Size	Natural logarithm of total assets at the end of year t-1
Asset structure	Ratio of current assets to total assets at the end of year t-1
Solvency	Ratio of total equity to total assets at the end of year t-1
Efficiency Ratio	Ratio of operating revenue to the total sum of equity and noncurrent liabilities computed at the end of year t-1
Liquidity Ratio	Ratio of current assets to current liabilities computed at the end of year t-1
Age	Number of years since the fintech was created at the end of year t-1
Other variables	
△Output value	Annual growth rate of output value, which is measured as the sum of total sales and changes in stock
△Op. costs	Annual growth rate of operating costs, which are measured as the sum of total inputs and personnel expenses
Google Trends	Annual average Google Trends index measuring the relative volume of online searches for fintech firm i in year t
△Retained earnings	Annual growth rate of firms' retained earnings

Table B.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
Banco de España Official Registry of Entities	Activities, registration numbers, dates of registration
Crypto assets and electronic wallet service providers and Real State Lending intermediaries (Banco de España 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	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