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The impact of Payment Services Directive 2 on the PayTech sector development in Europe



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ABSTRACT

The implementation of Payment Services Directive 2 (PSD2) has radically changed the regulatory environment for providing payment services in the European Economic Area. The main objective of the study is to determine the impact of PSD2 on the number of newly established PayTech companies. The second objective is to explain the factors driving the distribution of PSD2-licensed entities across the European Union countries. The difference-in-difference method and the Poisson regression model served our empirical analysis. The results show that the adoption of PSD2 in November 2015 caused a rapid but temporary surge in PayTech start-ups in Europe. After national transpositions of the directive, the number of new entrants fell in 2018; however, it remained at a higher level than before the adoption of PSD2, which indicates its positive impact. The analysis has proved that market potential, the characteristics of payment systems, including the popularity of payment cards, and the public environment for FinTech start-ups provided by the authorities significantly affected the number of PSD2 licences issued. The introduction of the PSD2 has made the size of the domestic market play a smaller role, as PayTechs can operate on a pan-European level also while based in a smaller country. The importance of an open business environment has increased and offering regulatory sandboxes has proven to effectively support the development of the PayTech sector.

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1. Introduction

The establishment and development of PayTech companies, which is a payment services-oriented part of the FinTech sector, results from the dynamic progress in digital technologies since the beginning of the 21st century in virtually every branch of the economy (Gomber et al., 2018). However, the payments sector in the European Union (EU) is special in that, in addition to technological progress, it is greatly influenced by legal regulations that have dramatically altered the relations between payment services providers and the conditions under which those services are provided (Jagtiani and John, 2018).

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The Single Euro Payments Area (SEPA) programme and the first Payment Services Directive (PSD) initiated these changes. However, the real change in the ‘rules of the game’ in the European retail payments market arises from the concept of ‘open banking’ (Zachariadis and Ozcan, 2016) and the second Payment Services Directive (PSD2),¹ and particularly of its novel access allowance to bank accounts for a new category of entities providing payment services – Third Party Providers (TPP), including non-bank entities (Drasch et al., 2018). Additional regulations accompanying PSD2 (Wolters and Jacobs, 2019) encompass Regulatory Technical Standards (RTS),² including Strong Customer Authentication (SCA). Clearly, there is a massive new playing field following these major regulatory changes under which the payment services market functions in the EU (Donnelly, 2016).

The development of open banking and the dynamic growth in the sector of non-bank PayTech entities requires systematic research. The first studies on open banking and the API economy (Philippon, 2017; Zachariadis and Ozcan, 2016), the legal (Steennot, 2018) and technical aspects (Mansfield-Devine, 2016; Wolters and Jacobs, 2019) have been already published (Gomber et al., 2017; Nicoletti, 2017). However, research on PayTech entities under PSD2 regulations has not been explored so far, mainly because of its recent occurrence. Moreover, no comprehensive studies regarding the factors determining the potential for the development of non-bank PayTech entities in different countries within the European Economic Area (EEA) have been conducted yet.

1. The main objective of the study is to determine the impact of Payment Services Directive 2 on the number of newly established PayTech companies.
2. The second objective is to explain the factors driving the distribution of PSD2-licensed entities across the European Union countries.

To the best of the authors’ knowledge, this is the first academic paper that: (a) applies the new and complex Payment Institutions Register started by EBA to obtain scientific evidence; (b) quantitatively evaluates the impact of PSD2 on the dynamics of incorporations of PayTech start-ups in the EU; (c) jointly examines the market potential of the country and public environment provided for FinTech start-ups by authorities, and (d) assesses the impact of payment system characteristics on incorporations of PayTech start-ups. The results are important for entrepreneurs preparing to enter the PayTech market in Europe, as well as for the EU lawmakers and the financial authorities of particular EU countries, who are considering the proper approach to licensing and supporting FinTech sector development.

This study is structured as follows: Section 2 contains a literature review and a description of the PSD2 regulation’s context, as well as the proposed research model of PayTech development. The data collection process and the growth of the PayTech market in the EU are presented in Section 3 based on descriptive statistics. The results from the difference-in-difference method and the Poisson regression model are presented and discussed in Section 4. The paper is concluded by providing a summary and establishing the scope for further studies.

2. Literature review

2.1. Fintech and PayTech research

The development of digital technologies and the automation of financial services have led to a revolution in the banking and payment sector (Bansal et al., 2015). It came with the emergence of companies known as FinTechs (Milian et al., 2019) and a change of business models from business- and banking-oriented to customer-oriented (Alt et al., 2018; Navaretti et al., 2017; Vives, 2019).

The term ‘FinTech’ is such a new concept that a common definition has not yet been agreed upon. Two main approaches competing in defining FinTech have been indicated in the literature (Harasim and Miłtręga-Nieśtrój, 2018). In the first approach – *defining by subject* – the emphasis is put on digital technologies, that are implemented by financial entities – banks or non-banks (Gomber et al., 2018; Ilyés and Varga, 2018; Navaretti et al., 2017; Vives, 2019). The other approach – *defining by object* – indicates the separate sector of non-bank financial entities whose business model is based on new technologies (Alt et al., 2018; Mico and Micu, 2016; Milian et al., 2019; Shim and Shin, 2016). However, some also propose definitions that combine elements from both approaches (Buchak et al., 2018; Kim et al., 2016). Between these two approaches, the definition of FinTech *by object* provides a practical opportunity to identify and separate entities that can be empirically analysed. This definition is also more in line with the approach taken under PSD2, where specific licences are intended for non-bank entities (see 2.2). Therefore, in this work, we have opted for defining FinTech and PayTech *by object*. In this context, FinTech entities operating in the payment sector are referred to as PayTechs.

FinTech has already been the subject of studies addressing many aspects of this phenomenon. An important direction of research was explaining the factors of FinTech development, i.e. regulatory support (Gomber et al., 2018; Jagtiani and

¹ Directive (EU) 2015/2366 of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market, amending Directives 2002/65/EC, 2009/110/EC and 2013/36/EU and Regulation (EU) No 1093/2010, and repealing Directive 2007/64/EC (Text with EEA relevance), *OJ L* 337, 23.12.2015, p. 35–127, <http://data.europa.eu/eli/dir/2015/2366/oj>

² Commission Delegated Regulation (EU) 2018/389 of 27 November 2017 supplementing Directive (EU) 2015/2366 of the European Parliament and of the Council with regard to regulatory technical standards for strong customer authentication and common and secure open standards of communication (Text with EEA relevance.) *C/2017/7782, OJ L* 69, 13.3.2018, p. 23–43, http://data.europa.eu/eli/reg_del/2018/389/oj

John, 2018; Kalmykova and Ryabova, 2016; Lee and Shin, 2018; Leong et al., 2017; Musa et al., 2017; Vives, 2019) or cross-organisational cooperation (Drasch et al., 2018; Polasik and Piotrowski, 2016; Szpringer, 2019). Competition between banks and FinTech companies (Buchak et al., 2018; Caporale and Caporale, 2008; Jagtiani and John, 2018; Li et al., 2017; Saksonova and Kuzmina-Merlino, 2017; Vives, 2019) and its impact on the stability of the banking sector (Kavuri and Milne, 2019; Vives, 2019) is also considered within this topic. Du et al. (2019), Gomber et al. (2018), Jünger and Mietzner (2019) examined usage the blockchain technology to financial market applications. However, the field of payments and development of PayTech entities were studied so far mainly as an addition to other aspects of FinTech (Gomber et al., 2017; Hill, 2018).

A notable exception is mobile payments that were already extensively studied in many dimensions (Dahlberg et al., 2015; de Luna et al., 2018; Karsen et al., 2019; Liébana-Cabanillas and Lara-Rubio, 2017). This was due to the growth in of mobile payment solutions, as a precursor to PayTech (Iman, 2018), both in highly developed and developing countries (Van Hove and Dubus, 2019) where they additionally play an important role in financial inclusion (Frost, 2020). The strictest legal framework regulating the PayTech sector exists in the EU, culminating in Payment Services Directive 2.

2.2. Payment Services Directive 2

Until the start of the 21st Century, payment services were not the subject to significant EU regulations (Brenner, 2019). This changed with the announcement of the Lisbon Strategy in 2000 and the launch of the SEPA (Single Euro Payment Area) project. The main aim of this programme was to harmonise and integrate electronic retail payments in Europe and whose implementation over the past 20 years has brought many changes to payment landscape in Europe (Bolt and Schmiedel, 2009; European Central Bank, 2019; Martikainen et al., 2015; Silva et al., 2016).

The regulation of the payment area began with the publication of the Electronic Money Directive (superseded by the Electronic Money Directive II in 2009). In 2007 the Payment Services Directive (PSD) was adopted – a much more extensive act created in order to restructure and further harmonise entire payments market within the EU. Both regulations created new entities: electronic money institutions (EMI) and payment institutions (PI), which, after obtaining appropriate licences from supervisory authorities, have the right to provide payment services alongside traditionally functioning credit institutions (i.e. banks).

On October 8, 2015, the European Parliament adopted a new directive that would replace the PSD from January 13, 2018, not fully coming into force until September 14, 2019. *'The revised Payment Services Directive (PSD2) provides the legal framework for retail payments innovation by setting rules for third-party payment service providers. PSD2 enhances consumer protection and increases security for payment services.'* (Mersch, 2019). In PSD2, to the previously binding list of services that can be provided by both credit institutions and payment institutions, were added: (1) payment initiation services (PIS) and (2) account information services (AIS). In PSD2, the AIS service is defined (in Article 4 (16)) as an online service consisting in providing consolidated information on at least one payment account held by a given payment service user with another payment service provider or with more than one service provider payment. The essence of the PIS service (in the context of Article 4 (15) of the PSD2 Directive) is the ability to initiate a payment transaction by a third party at the request of the payer from an account maintained by the payment service provider (Widawski et al., 2016). There is also a new licence (besides the ones concerning PI and EMI) for the Account Information Service Provider (AISP) issued to the entities providing the AIS service.

The PSD2 regulation was then transposed into the national law of individual EEA countries. The deadline for this implementation was set to January 13, 2018, but individual countries complied on different dates and usually by changing or adopting more than one national legal act (EUR-Lex, 2019).

These services pose a challenge to the traditional model of banks' operation because they allow external entities, called Third Party Providers, to obtain information, and initiate payments from consumer payment accounts operated by these banks. Therefore, the PSD2 Directive means the regulatory constitution of a new business model, which is called 'open banking'. It was supposed to constitute an incentive to accelerate innovation in the payment services market and create new opportunities for FinTech start-ups (Lautenschläger, 2019). Verifying if this incentive affects European start-ups is one of the aims of this work.

2.3. PayTech development factors

In accordance with the objectives of the work, two measures of the PayTech development were adopted: (1) the number of non-bank PayTech start-ups established, and (2) the number and types of PSD2 licences granted in each country.

Both internal and external factors influence the development of PayTech companies. Internal factors include, amongst other things, their organisational structure. Due to much simpler structures, PayTechs (but also FinTechs in general) are more agile, allowing them to deploy new technologies faster than traditional banks; thus they become banks' competitors (Davies et al., 2016; Jagtiani and John, 2018; Leong et al., 2017; Saksonova and Kuzmina-Merlino, 2017; Szpringer, 2019; Vives, 2019). External factors comprise: technology developers, customers using financial services, and other financial institutions, and the legal environment in which these entities operate (Alvarez and Barney, 2013; Davidsson et al., 2018; Lee and Shin, 2018; Ramoglou and Tsang, 2016; Shane and Venkataraman, 2000). Moreover, external factors indicate technological

progress, demographic trends, regulatory changes, and changes in the socio-cultural, economic and political environment (Davidsson et al., 2018; Shane and Venkataraman, 2000).

In order to examine the factors significant in the development of PayTech companies, external and internal factors were categorized into three groups as a research model: (a) the market potential in the country concerned, (b) the level of development of the payment system, and (c) the public environment for FinTech start-ups, including the regulatory framework.

A number of indicators are used in the literature as a measure of market potential (group a – the market potential in the country concerned),³ such as domestic trade flows and output, proxies for domestic trade cost (Jacks and Novy, 2018; Redding and Venables, 2004), GDP, GDP per capita, GDP growth rate, and population (Reiljan, 2003). The article takes GDP per capita and population as the measures of market potential.

Customers' payment habits and the level of development of payment infrastructure (group b – the level of development of the payment system) may create both opportunities and barriers in the development of individual PayTech solutions (Bagnall et al., 2016; Esselink and Hernández, 2017; European Central Bank, 2014), and differentiate consumer readiness to adopt PSD2-based services (Bijlsma et al., 2020). For example, direct debit is seen more as an indicator of the popularity of traditional banking services (Wonglimpiyarat, 2017). Card payments, on the other hand, are perceived as a method often used in e-commerce (Deufel et al., 2019) and allowing for simple integration with PayTech solutions, as exemplified by the payment services offered by BigTechs (Frost et al., 2019). Therefore, issuance and use of payment cards, direct debits, and credit transfers per capita were applied to measure the development of the payment system.

Government and regulatory support (group c – public environment) plays an undeniable role in FinTechs' development (Jagtiani and John, 2018; Lee and Shin, 2018; Leong et al., 2017; Musa et al., 2017; Vives, 2019), and sometimes leads start-ups to apply regulatory arbitrage (Buchak et al., 2018; Frost, 2020). For FinTech start-ups, the launch of a regulatory sandbox and innovation hubs is an important form of direct government support (European Supervisory Authorities, 2018). As Lee and Shin (2018) point out, governments have a diverse policy on access to financial services. This is particularly important for FinTech entities in the payment industry, development rapidly and implementing of new technologies which are not always kept up with by legal regulations (Kalmykova and Ryabova, 2016). This creates significant challenges for financial supervision (Gomber et al., 2018). In turn, the general economic climate, including the ease of setting up and running a business, affects all market entrants (Djankov et al., 2010, 2002), including PayTechs. The leading indicator of ease of doing business for researchers, policymakers, and the media is the set of indices presented in the 'Doing Business' report, covering 190 countries in 2018 (Malone et al., 2019; Teague, 2016). In the work, the value of the 'Starting a business' index and whether the authorities have created innovation hubs and regulatory sandboxes for FinTech were used as measures for the openness of the regulatory environment.

Based on the aforementioned discussion, the following research questions arise:

- Q1: Did Payment Services Directive 2 affect the development of the PayTech sector measured by the number of newly incorporated financial start-ups?
- Q2: Is the size of a national e-commerce market important in attracting PayTech start-ups to establish their headquarters in a given country?
- Q3: Does a friendly public environment for FinTech start-ups, which may include regulatory sandboxes, effectively stimulate PayTech entrepreneurship in a country?
- Q4: Do the patterns of using traditional banking payment instruments – payment cards, credit transfers, and direct debits – influence the development of the PayTech sector?

3. PayTech development in the European Union

3.1. Data collection

Data on the payment licences were obtained from the European Banking Authority's (henceforth: the EBA) Payment Institutions Register (2020) which is a comprehensive, regularly updated source of data on the licences obtained by non-bank PayTech companies in the European Economic Area (EEA). The dataset used in this paper was retrieved on 31 December 2019 and contained 5811 payment institutions, 552 branches, and 223,326 payment agents licensed until that date.³

The analysis of the EBA data is limited to three types of institutions (henceforth *licensed institutions*): (1) *Payment Institutions* (PI), (2) *Electronic Money Institutions* (EMI) and (3) *Account Information Service Providers* (AISP). We excluded institutions which were licensed outside the full scope of PSD2 and therefore were not allowed to provide payment services outside of the country they gained licences in.⁴ The sample is also limited to EU member states, which results from the fact that complete and methodologically coherent data pertaining to the payment system and the conditions of doing business are available only for these countries.

³ Observations with incomplete records were excluded from our sample. This concerned less than 1% of the total number of records.

⁴ Excluded categories include: (1) Exempted payment institutions, (2) Exempted electronic money institutions, (3) Service Providers Excluded from Scope of PSD2 and (4) Institutions entitled under national law to provide payment services. Most of those exempted companies were providing only local money remittance services or could provide issuing or acquiring services only on a very small scale of transactions processed in a year with a value not exceeding EUR 3 million.

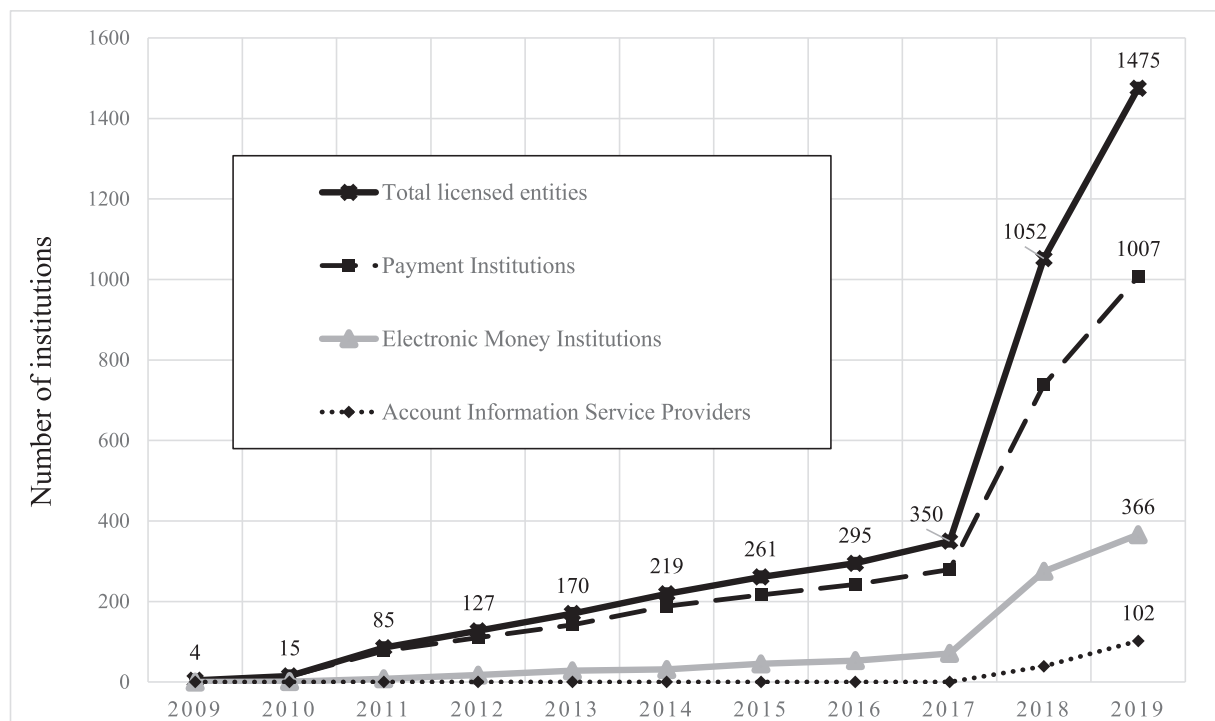


Fig. 1. Type and number of payment licences issued over time in the European Union (cumulative)
Source: Statistics based on the EBA Payment Institutions Register, <https://euclid.eba.europa.eu/>.

The data from the EBA register were supplemented with company data from the Orbis database (Bureau van Dijk, 2020). All the companies which obtained licences under PSD2 were looked up in the Orbis database for (a) the date of their incorporation and (b) the identification of their economic activity according to NACE. Dates of incorporation were necessary to create a variable that aggregates the number of PayTech companies established in each country in a given month within the *treatment group* (see Table 4), used in the difference-in-difference analysis (see 4.1). Moreover, the six most common NACE codes of the PSD2-licensed companies (see Table 7 – Appendix), that represent more than 84% of all these companies were selected as the identification of a *control group* (see Table 4). Then, all companies from EU countries conducting activity for selected NACE codes were searched, and for such control group data for their incorporation date, the NACE codes and the country of registered office were received from the Orbis database.

3.2. Dynamics of the PayTech market development

The number of non-bank PayTech companies in the EU operating under the analysed licence types has been growing in the last few years (Fig. 1). A surge in the number of licences occurred in 2018, the year when the majority of EU countries carried out national transpositions of PSD2. As seen in Fig. 2, the number of licences granted within the EU increased fourfold in just 24 months, from 350 entities in 2017 to 1475 entities in 2019. By the end of 2019, the Payment Institution licence was the most popular amongst non-bank PayTech entities, followed by that of an Electronic Money Institution. Account Information Service Provider was the least popular licence, mostly due to the short time of its availability up to the moment of study and the limited scope of activities allowed under this licence.

The PSD2 regulation affects various aspects of the PayTech sector. New opportunities could generate better prospects for investors and therefore attract new companies (start-ups). For the purposes of the study, the number of newly established non-bank start-ups, providing payment services under one of the above mentioned PSD2 licences, was used as a measure of the development of the PayTech sector (see 2.3).⁵

However, the sharp increase in the number of licences granted since 2018 (Fig. 1) does not yet imply the impact of PSD2 on entrepreneurship, and the incorporation of PayTech start-ups in Europe. Also non-bank entities established a long time before the PSD2 could have applied for the payment licences under the new regulation because it was required for the continuation of their existing business. In addition, existing entities might have been interested in expanding their existing

⁵ Alternative measures of sector development are not available or reliable. Start-ups are typically not publicly traded and therefore market value data are not available. New start-ups also often follow aggressive growth strategies which are not focused on current profits.

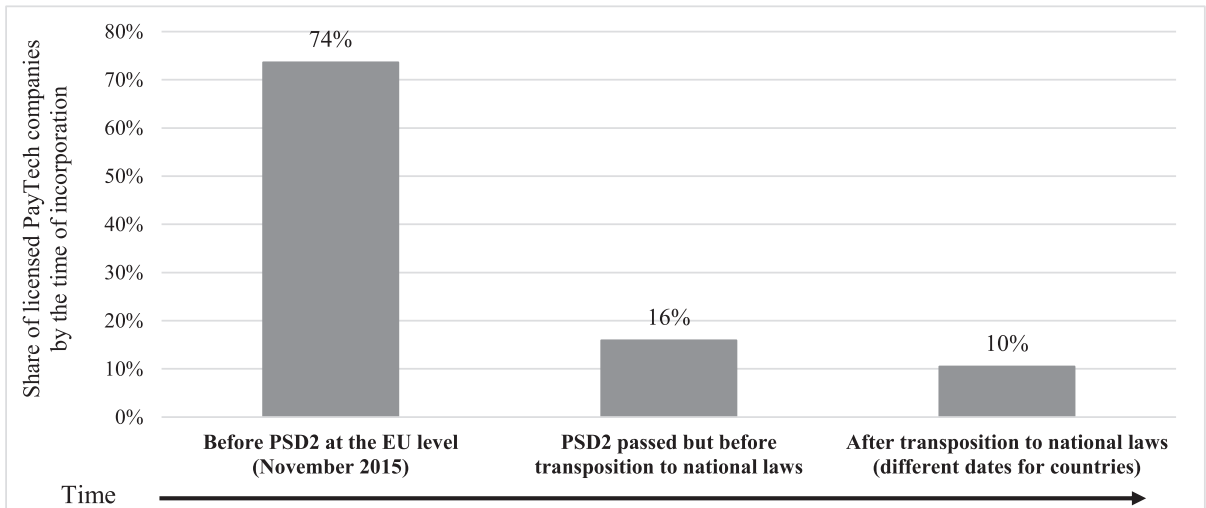


Fig. 2. Share of licensed PayTech companies by the time of incorporation related to the PSD2 legal process

Source: Statistics based on the Orbis database (Bureau van Dijk, 2020), the EBA Payment Institutions Register, <https://euclid.eba.europa.eu/> and PSD2's national transposition dates (EUR-Lex, 2019); Data up until the end of 2019.

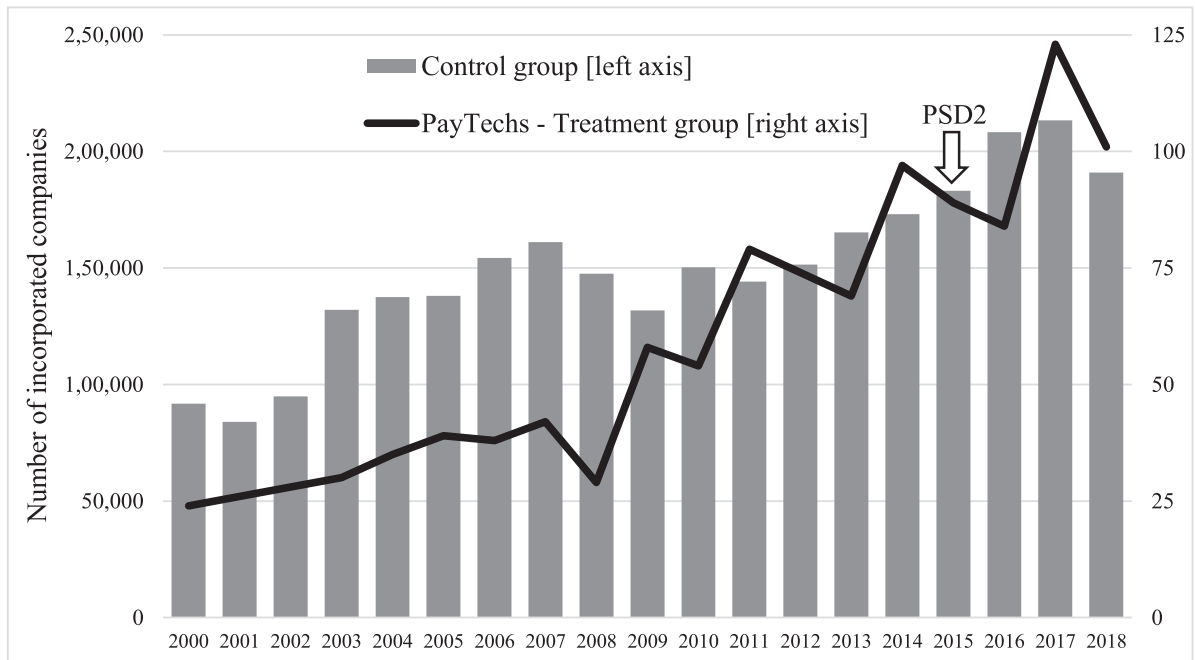


Fig. 3. Comparison of PSD2-licensed and non-licensed company incorporations over time in the European Union

Source: Statistics based on the Orbis database (Bureau van Dijk, 2020) and the EBA Payment Institutions Register, <https://euclid.eba.europa.eu/>.

business into a new area, considering the PSD2 regulations to be beneficial to them. By the end of 2019 almost 75% of all studied PSD2 licences were granted to entities that had been established before the adoption of this regulation at EU level (see Fig. 2). Thus, only around a quarter of all new PayTech licences were associated with new incorporations and can be directly related to the stimulation of entrepreneurship by PSD2.

Interestingly, the vast majority of these newly established PayTech start-ups were founded in the period before the national transpositions of PSD2 (Fig. 3). This may suggest that investors and innovators in the PayTech industry anticipate regulatory changes and start new companies well in advance. After the national transpositions of PSD2, the drive to establish new PayTech entities slowed down. This data significantly change the view on the effects of PSD2's introduction and indicate that a detailed quantitative analysis, taking into account external factors, is needed to assess them in depth.

The tendency to set up new businesses may be related to other factors -macro-economic ones, for instance. Therefore, the identification of the effect of PSD2 on the PayTech sector (*treatment group*) development needs a comparison with a

Table 1
EU countries with the highest number of PayTech institutions.

Country	Number of Institutions	Average number of markets licensed to be served
United Kingdom	627	17.31
Lithuania	100	13.15
France	82	8.40
Germany	72	6.88
Netherlands	57	12.81
Spain	57	10.04
Sweden	56	6.86
Italy	50	2.12
Poland	45	10.27
Malta	41	12.80

Source: Statistics based on EBA Payment Institutions Register, <https://euclid.eba.europa.eu/>.

larger group of similar entities not directly affected by PSD2. Such a benchmark (*control group*) was constructed based on NACE codes of companies from the treatment group.⁶

Fig. 3 compares the number of newly incorporated companies by year – companies licensed under PSD2 (*treatment group*) with companies from the *control group*. The number of companies which eventually obtained the payment licences under PSD2 (until the end of 2019), grew over time. There was a major increase in PSD2-licensed companies in 2017 while the growth of the control group in the same period remained steady. This suggests a surge in new companies in 2017 in anticipation of PSD2 implementation. Quantitative verification of this observation was performed in Section 4.2.

3.3. PayTech licences distribution in the EU countries

The cross-country analysis applies two types of general measurements of PayTech development. The first one concerns the country where non-bank PayTech companies obtain licences (assumed headquarters) and the second comprises countries where they are allowed to provide services under the PSD2-licences granted (assumed market).

Based on data presented in Fig. 4 below, the United Kingdom is an unquestionable leader in terms of PayTech development. By the end of 2019, the financial supervision of this country issued as many as 627 PayTech licences, which constituted 43% of all 1475 analysed licences in the European Union. Until recently, for other countries to catch up with the UK seemed an impossible task, as there are several times more PayTech institutions there than in any of the other countries. However, Brexit may well pose a risk for the UK's standing, when after the transition period (which ends on 31 December 2020⁷) all financial institutions that are licensed in the UK will lose the right to render their services inside EU. Companies that wish to continue providing PayTech services must apply for a licence in an EU country (Armour, 2017).

The analysis of the number of licences obtained reveals that the top ten countries include all five largest EU member states in terms of population and GDP (Fig. 4). It seems evident that this is the result of the great economic potential of these countries. On the other hand, however, there is a group of smaller EU countries that offer incentives for payment licensing (e.g. easy registration process), which encourages investors to register there (European Supervisory Authorities, 2018). These include in particular Lithuania and Malta which have attracted a large number of institutions relative to their population. Small countries in which the number of registered companies seems to significantly exceed their internal market potential attempt to be PayTech centres or hubs and make substantial investments in the sector. One of the most interesting examples of a country developing PayTech sector is Lithuania, which is the second-largest PayTech hub in Europe. Lithuania's internal consumer base has a low ceiling, so the attractiveness of its local market for investors is below average. Still, it managed to attract numerous PayTech entities, focused primarily on providing cross-border services in other EU countries. This implies that using the strategy of creating a friendly environment for the PayTech sector was successful in the case of Lithuania (Table 1).

PayTechs may apply for a licence to provide services to more than one country in Europe by the regulations of *passporting* for financial institutions (European Parliamentary Research Service, 2017). It allows entities authorised in a European Economic Area (EEA) state to carry out activities in any other EEA state without additional authorisation. Tables 4 and 5 show the rankings of the top ten countries in terms of the number of non-bank PayTech institutions licensed and the average number of markets where these institutions are allowed to provide services. The United Kingdom, Lithuania, the Netherlands, and Malta appear in both of these tables. This indicates the significance of these countries in the European Union as perceived hubs for PayTech companies. In larger countries, with a more traditional approach of regulatory authorities, PayTech start-ups are allowed to serve a smaller average number of other EU markets – e.g. 2.12 for Italy and 6.88 for Germany. It suggests that payment institutions registered there are mainly focused on the local market. In contrast, companies

⁶ Six most common NACE codes of the PSD2-licensed companies (see Table 7 – Appendix), that represent more than 84% of all these companies were selected. We retrieved all EU-based companies sharing these NACE codes from the Orbis database together with their incorporation dates (see Section 3.1).

⁷ Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, *Of L 29, 31.1.2020, p. 7–187*, [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:2020A0131\(01\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:2020A0131(01))

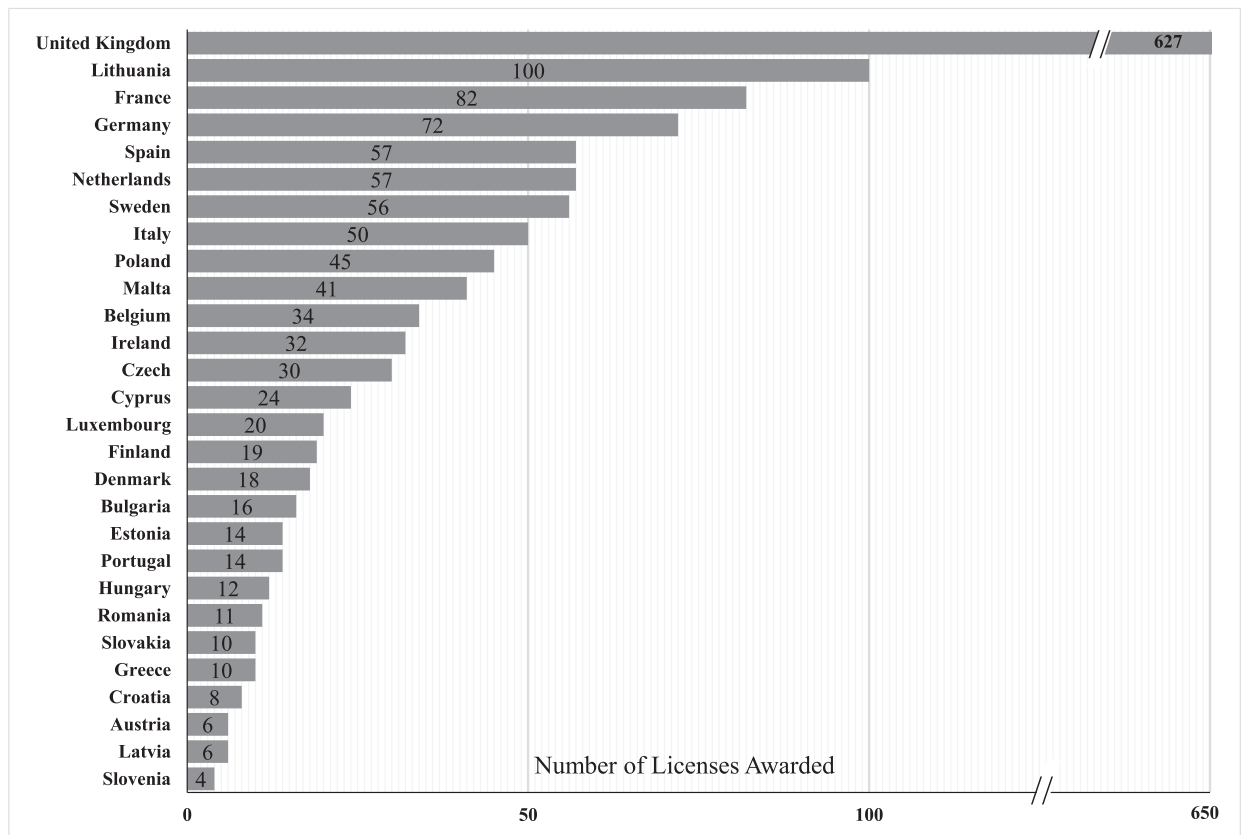


Fig. 4. Type and number of payment licences issued in the EU countries by the end of 2019
 Source: Statistics based on the EBA Payment Institutions Register, <https://euclid.eba.europa.eu/>.

Table 2
 EU countries with PayTech institutions serving most markets on average.

Country	Number of Institutions	Average number of markets licensed to be served
Luxembourg	20	23.05
Cyprus	24	21.54
Austria	6	17.50
United Kingdom	627	17.31
Ireland	32	16.22
Belgium	34	14.88
Lithuania	100	13.15
Netherlands	57	12.81
Malta	41	12.80
Slovakia	10	12.20

Source: Statistics based on EBA Payment Institutions Register, <https://euclid.eba.europa.eu/>.

in Luxembourg and Cyprus apply for licences to provide services in the largest number of markets (Table 2) – 23.05 and 21.54 on average, respectively. It can be assumed that some entities establish their headquarters in these countries because of regulatory arbitrage (Boyer and Kempf, 2020; Houston et al., 2012; Philippon, 2017). It seems that these companies are seeking a friendly regulatory environment in one country, but are focused on serving cross-border EU markets.

The analysis presented above suggests that both – the size of the local market in a given country and the regulatory policy – are essential for the development of the PayTech sector.

4. Empirical results

4.1. Data analysis

Based on the literature review (Section 2) and the developed research framework, a set of variables used for empirical analyses was selected. They are presented in Table 3 and Table 8. For the analysis of the incorporation of start-ups based

Table 3
Variable definitions.

	variable name	definition
Dependant variables	<i>paytechs before psd2</i>	number of entities granted payment licence established before approval of psd2 at the ue level (European Banking Authority, 2020)
	<i>PayTechs Before National Law</i>	Number of PayTech entities established after PSD2 approval but before the transposition of PSD2 to the national laws in individual countries (European Banking Authority, 2020)
	<i>PayTechs After PSD2 Transposition</i>	Number of new PayTech entities established after the transposition of PSD2 to the national law in individual countries (European Banking Authority, 2020)
Time-variant indicator variables	<i>E</i>	Number of incorporated companies (market entries) by Orbis database (Bureau van Dijk, 2020)
	<i>PAYTECH</i>	Indicator variable for companies licensed under PSD2 by the end of 2019 (European Banking Authority, 2020)
	<i>EUPSD2</i>	Indicator variable for the period after the approval of PSD2 at EU level (EUR-Lex, 2019)
Market potential	<i>NPSD2</i>	Indicator variable for the period after publication of last law implementing PSD2 at national level (EUR-Lex, 2019)
	<i>Population</i>	Total Population of a country in 2018 (Eurostat, 2019)
	<i>GDP (in million EUR)</i>	Gross domestic product of a country in euros in 2018 (Eurostat, 2019)
Public Environ-ment for FinTech start-ups	<i>Internet purchase</i>	Share of the population using the internet for ordering goods or services in 2018 (Eurostat, 2019)
	<i>Innovation Hubs</i>	Dedicated point of contact for firms to raise enquiries with competent authorities on FinTech-related issues (European Supervisory Authorities, 2018)
	<i>Sandbox</i>	The number of regulatory sandboxes operational in a country (European Supervisory Authorities, 2018)
Payment system	<i>Starting a business</i>	Score awarded to a country for ease of starting a business; an indicator of procedures, time, cost and paid-in minimum capital to start a limited liability company asseset in 'Doing bussienss' report (World Bank, 2018)
	<i>Card payments per capita</i>	Number of card transactions per capita in a country in 2017 (European Central Bank, 2020)
	<i>Credit transfer per capita</i>	Number of credit transfer transactions per capita in a country in 2017 (European Central Bank, 2020)
	<i>Direct debit per capita</i>	Number of direct debits transactions per capita in a country in 2017 (European Central Bank, 2020)
	<i>Cards issued per capita</i>	Number of payment cards issued per capita in a country in 2017 (European Central Bank, 2020)
	<i>Instant payments</i>	Domestic instant payment system operating in a country [dummy variable 0–1] (Hartmann et al., 2019)

on the difference-in-differences (DID) framework ([Section 4.2](#)), the dependant variable *E* and the indicator variable *PAYTECH* were used, which divides the incorporated companies into the *control group* and *treatment group* of companies that were licensed under PSD2 by the end of 2019. Two other indicator variables were used to set the time frame for the impact of the PSD2 regulation on the payment market. *EUPSD2* is an indicator variable for the period after the approval of PSD2 at EU level on 25 November 2015. *NPSD2* identifies for the period after publication of the last law implementing PSD2 at the national level, separately for each country's date of transposition ([EUR-Lex, 2019](#)).

Another set of dependant variables – *PayTechs Before PSD2*, *PayTechs Before National Law*, *PayTechs After PSD2 Transposition* – was used in the modelling of the determinants of the number of licences issued in a given country, based on cross-country count data analysis ([Section 4.3](#)).

A set of eleven independent variables was used in both types of analysis – the DID method and count data estimations. The variables are grouped according to the adopted research model ([Section 2.3](#)). The market potential is represented by the following variables: *Population*, *GDP* (in EUR million), and *Internet purchase*. The last variable is particularly important since PayTech3's offer is most often directed to payments in e-commerce purchases. Three variables measure the activities of authorities within the area of public environment for FinTech start-ups: *Innovation Hubs*, *Sandbox*, *Starting a business*. Five variables describe the characteristics of each domestic payment system: *Card payments per capita*, *Credit transfer per capita*, *Direct debit per capita*, *Cards issued per capita*, and the fact of possessing a domestic *Instant payments system*. Independent variables are country-assigned and time-invariant as they are subject to only minor changes over time.

[Table 6](#) (see Appendix) reports the summary statistics for the variables used in the study. Cross-country data covers 28 EU countries. They indicate the diverse average levels of the phenomena taken into account. Data differences are particularly pronounced in the case of the payment system. For instance, the average number of *card payments per capita* varied between 18 and 366 transactions per year. In some countries, there were no *direct debit* transactions, while in others, they were popular. Only four countries had a domestic *Instant payment system*; still an innovation in Europe. *Starting a business* indicator was less diversified, ranging from 82 points for the most bureaucratic country (Slovakia) to 96 points for the most business-friendly country (Ireland). As many as 75% of all countries had established an *Innovation hub* dedicated to supporting FinTech. However, only 30% of countries had a regulatory *Sandbox*, since that requires more involvement of the authorities. *Internet purchases* were standard in some countries (84% of citizens), while in the least advanced countries they were only employed by every fifth person.

The time-variant variables reported in Panel B (see Table 6 – Appendix) include monthly data for 28 countries from 2000 to 2018, covering the number of newly incorporated entities classified as the *control group* and the *treatment group* (see Section 3.1). Since granting a licence under PSD2 usually requires passing a procedure lasting many months, not all entities incorporated in 2019 could obtain such a licence and be registered in the EBA Payment Institutions Register by the end of that year. To prevent this fact from impacting the results, it was assumed that the PayTech sector development within the difference-in-differences framework (see 4.2) would only encompass entities established by the end of 2018.

4.2. Impact of PSD2 on PayTech sector development

To verify the effect of PSD2 on PayTech sector development measured by the number of newly incorporated start-ups (see Section 3.1), the triple difference-in-differences (DiD) framework was applied. It allowed us to disentangle the effect of PSD2 regulation and overall development in the technological (IT) and financial sectors. For the DiD analysis, a *control group* was constructed (see Sections 3.1 for the data collection procedure) consisting of companies which (a) are doing business in the same or similar sector to PayTech companies (as defined by NACE code), and (b) are not subjected to the PSD2 regulation. The *control group* consists of new enterprises in IT services and non-bank and non-insurance financial activities (see Table 7 – Appendix). The *treatment group* consists of PSD2-licensed companies – Payment Institutions, Electronic Money Institutions, and Account Information Service Providers.

The PSD2 regulation was introduced in two steps. First, the regulation was passed at the European level and subsequently, it was transferred by member states into national law (see Section 2.2). To capture potentially different effects of both steps, an estimation of the following empirical specification was applied:

$$E_{ist} = \alpha + \beta_1 \text{PayTech}_i \times \text{EUPSD2}_t + \beta_2 \text{PayTech}_i \times \text{EUPSD2}_t \times \text{NPSD2}_{it} + \beta_3 \text{PayTech}_i + \theta_i + \theta_s + \theta_{\text{year}} + \varepsilon_{ist} \quad (1)$$

where $E_{i,t}$ is the number of incorporated companies, s is sector, and t is time (month and year) t . The effect of passing PSD2 at European level is captured by the interaction of indicator variable PayTech_i which is equal to one for groups of companies licensed under PSD2, and indicator variable EUPSD2 for PSD2 being approved at EU level. The triple difference term identifies the effects of PSD2 adoption at national level (NPSD2 indicator variable). To control for country- and sector-specific unobserved characteristics, including country (θ_i) and sector (θ_s), fixed effects were included. The year fixed effect (θ_{year}) controls for idiosyncratic shocks. Variable ε_{ist} is the error term.

Since granting a licence under PSD2 usually requires passing a procedure lasting many months, not all entities incorporated in 2019 could obtain such a licence and be registered in the EBA Payment Institutions Register by the end of that year. To prevent this fact from impacting the results, we limit the estimation sample to companies incorporated in 2018 or earlier.

The number of incorporated companies is a count data variable with a high share of zeros (79.5%). Therefore the performed analysis follows Silva and Tenreyro (2011, 2006) who propose using the Poisson Pseudo-maximum likelihood (PPML) estimator in such a case.⁸

The estimated coefficients for specification (1) are presented in column (1) in Table 4. Results show that PSD2 approval in the European Parliament has led to the growth of the number of companies in the regulated sector. After the introduction of PSD2, the number of newly incorporated PayTech start-ups increased by 70%. This result is a quantitative confirmation of the positive impact of PSD2 on the development of the PayTech sector, as suggested by the previous descriptive analysis (see Figs. 1 and 3).

However, the adoption of PSD2 at the national level cut the surge. After the national transpositions, the number of PayTech start-ups decreased by 36% on average for all EU countries (compared to the period after PSD2 approval and before the national transpositions). This suggests that the strong impact of PSD2 was temporary and decreased after the first wave of incorporations. It can be assumed that this effect was due to the fact that investors and innovators started preparing to operate under the new PSD2 regulations already after EU-level approval. They rushed to register new PayTech start-ups to occupy a new attractive market niche before it was even possible to apply for a licence. One can say that in 2017 there was a hype for investing in PayTech start-ups (see Fig. 4). However, after the national transpositions of PSD2, when the new entities had to bear the costs associated with applying for a licence and operating, this market experienced some rationalisation and a decrease in the number of market entrants. The evaluation of the long term impact of PSD2 on PayTech sector development will require studies in the future.

Specifications presented in columns (2)–(5) replace the country fixed effects with various country-level time-invariant characteristics. Variables tested belong to three areas of the research model (Section 2.3): payment system, public environment for FinTech start-ups, and market potential. The results indicate that under a payment system *Card payments per capita*, *Direct debits per capita*, and the operation of a national *Instant payments* system have a positive impact on the number of start-ups established in a given country, both for the control group and the treatment group. On the other hand, in countries with a large number of *Credit transfers per capita*, generally fewer new enterprises were registered. In turn, a country's high position in the *Starting a business* ranking (denoting to a friendly climate for entrepreneurship) has a positive impact on the overall number of start-ups. The same is true of *Sandboxes* which, when present, mean that the authorities have the policy

⁸ For interpretation of PPML coefficients see Silva & Tenreyro (2006).

Table 4

The results of the difference-in-differences (DiD) analysis.

	Dependant variable: number of incorporated companies				
	(1)	(2)	(3)	(4)	(5)
Effect of PSD2 approval at European level ($PayTech_i \times EUPSD2_t$)	0.530** (0.220)	0.482** (0.226)	0.343 (0.223)	0.476** (0.224)	0.4795** (0.227)
Effect of PSD2 transposition to national laws ($PayTech_i \times EUPSD2_t \times NPSD2_{it}$)	-0.451*** (0.129)	-0.317*** (0.146)	-0.176 (0.174)	-0.301** (0.150)	-0.2867** (0.142)
PSD2-licensed companies	-8.413*** (0.357)	-8.413*** (0.357)	-8.425*** (0.360)	-8.413*** (0.357)	-8.4247*** (0.360)
<i>Card_payments_per_capita</i>		0.006*** (0.002)			0.0005 (0.004)
<i>Credit_transfers_per_capita</i>		-0.015*** (0.005)			-0.0031 (0.006)
<i>Direct_debits_per_capita</i>		0.028*** (0.003)			0.0117 (0.011)
<i>Instant_payments</i>		1.318*** (0.392)			1.1591 (0.710)
<i>Innovation_hubs</i>			-0.481 (0.586)		0.1594 (0.954)
<i>Sandbox</i>			1.628*** (0.602)		0.5427 (0.431)
<i>Starting_a_business</i>			0.147* (0.079)		0.0507 (0.062)
$\log(GDP\ per\ capita)$				0.314 (0.429)	1.6750 (0.593)
$\log(Population)$				0.750*** (0.138)	0.5259* (0.270)
<i>Internet_purchase</i>				4.853** (1.906)	0.1672 (2.939)
Intercept	-8.020*** (1.204)	-9.884*** (1.164)	-26.980*** (7.314)	-27.254*** (4.289)	-35.0491*** (7.091)
Country FE	Yes				
Year FE	Yes	Yes	Yes	Yes	Yes
Sector (NACE) FE	Yes	Yes	Yes	Yes	Yes

Standard errors clustered by country and sector pairs are reported in parentheses with * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$. The treatment group used in the analysis was limited to 555 market entries from 719 PayTech start-ups; others had some data incompleteness.

to support innovation. An important stimulus for entrepreneurship related to new technologies and FinTech is consumer use of electronic distribution channels, as more companies are established in countries where online shopping is popular (*Internet purchase*). In turn, the positive impact of country size measured by *Population* is a standard result. In general, there were no significant differences between the impact of country-level variables on the number of incorporated companies in the treatment group and the control group.

4.3. Cross-country differences in PayTech licencing activity – count data analysis

The above analysis concerned the EU-wide impact of PSD2 without differentiating the incorporated start-ups according to the location of their headquarters. Meanwhile, the diversity of the European Union countries means that the development of the PayTech sector is not evenly distributed. Therefore, an additional cross-country analysis was carried out to examine the impact of economic factors, the diversity of the payment systems, and the regulatory environment on the number of each of the three types of PayTech licences obtained in individual countries.

For the assessment of factors influencing the number of licences granted in a given country, a count variable model (the Poisson regression model) was estimated. Poisson regression is used to model past events, which, in this study, take the form of granting a licence to operate as a non-bank PayTech. In the model, endogenous variables that take non-negative integer values (count variables) were used (Cameron and Trivedi, 2005; Wooldridge, 2001). During the analysis (Table 5), we have separately estimated the number of entities: (a) granted a payment licence established before the approval of PSD2 at the UE level (*PayTech Before PSD2*), (b) new PayTech entities established after PSD2 approval but before the transposition of PSD2 to the national laws in individual countries (*PayTech Before National Law*) and (c) new PayTech entities established after the transposition of PSD2 to the national law (*PayTech After PSD2 Transposition*). Due to the small cross-country sample covered in the research (28 EU member states), it was indispensable to limit the number of independent variables used to study the determinants of the number of licences granted (see Table 3 in Section 4.1 and Table 6 in Appendix for variable descriptions). These variables cover all three areas identified under the adopted research model (see Section 2.3).

The obtained results shown in Table 5 confirmed earlier observations of the distribution of licences by country (Fig. 4; Section 3.3), that market potential significantly stimulates the PayTech sector development. It was certainly the case before the adoption of PSD2. In order to present market potential, two variables were employed – \log of *Population*

Table 5

The results of the Poisson regression model's estimation.

Variable	PayTechs Before PSD2	PayTechs Before National Law	PayTechs After PSD2 Transposition
<i>const</i>	−12.9110*** (1.090)	−8.865*** (2.536)	−22.902*** (4.652)
<i>Log(Population)</i>	0.653*** (0.047)	−0.181* (0.095)	−0.236 (0.164)
<i>Internet purchase</i>	2.638*** (0.417)	1.307* (0.757)	0.772 (1.277)
<i>Starting a business</i>	0.039*** (0.010)	0.137*** (0.025)	0.296*** (0.044)
<i>Sandbox</i>	0.307*** (0.096)	1.435*** (0.192)	1.839*** (0.273)
<i>Cards issued per capita</i>	0.737*** (0.072)	0.400*** (0.139)	0.387 (0.253)
<i>Credit transfer per capita</i>	−0.005*** (0.001)	−0.014*** (0.003)	−0.025*** (0.005)
<i>Direct debit per capita</i>	−0.007*** (0.002)	−0.013*** (0.005)	0.025*** (0.008)
McFadden R-square	0.817	0.572	0.713

Standard errors clustered by country and sector pairs are reported in parentheses with * $p < 0.1$, ** $p < 0.05$, and *** $p < 0.01$.

and percentage of online shoppers (*Internet Purchase*). Both of the variables had a significant positive impact on the number of licensed institutions before the adoption of PSD2. In both cases, this impact was weakened by implementing PSD into national laws of European Union countries. In the case of *Population*, it has taken a negative direction, which is a statistical confirmation of the success of smaller countries in attracting newly established PayTech start-ups. The significance of both these variables vanished with the implementation of PSD2 into national laws. The potential of the domestic market had a greater impact while payment services delivered by third parties were in their infancy, and when the harmonisation of legal regulations had not yet taken place. Since PayTechs and their services started gaining popularity and PSD2 became more broadly implemented, other factors came to the fore.

A friendly environment for establishing new enterprises, expressed with the *Starting a business* indicator, proved to be positively correlated with the number of licences obtained by non-bank PayTechs. Additionally, the decision of PayTech companies to apply for a licence in a given country is positively influenced by the existence of a regulatory sandbox in that country. Furthermore, sandboxes incentivise entities that have already taken part in them to obtain a licence in a given country. More so, the impact of both of those variables has been growing strongly over time together with the process of implementing PSD2 (Table 6). These results provide evidence that financial authorities possess administrative and legal tools to stimulate the development of the PayTech sector (Boyer and Kempf, 2020; Philippon, 2017). The activity of countries that have already established PayTech hubs in Europe (see Section 3.3) proved that the creation of a friendly environment for FinTech is effective.

The very fact of having a regulatory sandbox seems to be an indicator of the positive attitude that supervisory bodies in a given country hold towards the development of financial innovation. However, individual sandboxes differ significantly in terms of objectives, mechanisms, and rules adopted for the participating start-ups. They also operate under different national legal systems. Therefore, the issue of regulatory sandboxes requires further in-depth studies that will take into account specific legal and institutional mechanisms of their operations in EU member states, as well as their precise outcomes.

The specific features of a domestic payment system strongly affect the PayTech sector's development. Before PSD2, more entities applied for all types of licences in countries where consumers held more payment cards (*Cards issued per capita*). Since in most European countries payment cards were the dominant way to perform online shopping (Deufel et al., 2019), their use indicates precisely where PayTechs would start building their businesses in hope for fast growth. Moreover, owing to tokenisation and digital wallets, cards can be flexibly integrated with innovative solutions offered by non-bank PayTech providers (Laboure and Reid, 2020; Milkau, 2020). However, since one of the reasons AIS and PIS services were created was to compete with payment cards, the popularity of this instrument started to be insignificant after the implementation of PSD2 into national laws.

The popularity of bank transfers has the opposite effect on the development of the PayTech sector. *Credit transfer per capita* is negatively associated with the number of licensed institutions. It is surprising as the credit transfer is the primary instrument for the clearing of transactions for services provided under PSD2. The negative correlation may result from the fact that the highest share of credit transfer transactions amongst cashless payments is recorded mostly in the post-socialist countries of Central Europe (see current ECB Payment Statistics (2020) and Silva et al. (2016)). The PayTech sector is generally not very active in these countries (see Fig. 4). Earlier studies revealed the impact of institutional and cultural factors on entrepreneurship and the specifics of payment services usage in these countries (Deufel et al., 2019; Martikainen et al., 2015).

Before the implementation of PSD2 into national laws, the widespread use of *direct debit per capita* had a negative impact on the number licences in a given country. This may be due to some conservative features of this payment instrument which

require additional paperwork between the payee and the payer before transactions are finished and that the payment may be refunded (withdrawn) by the consumer within a month (Bacs, 2015). Direct debits are usually reasonable when it comes to bill payment or other recurring transactions based on an agreement between parties. However, it is not suitable for immediate one-off transactions between parties that do not trust each other – typical for e-commerce (The Paypers, 2019). It seems that initially, PayTechs tried to reach ‘low hanging fruit’ in markets where payment cards were more popular. With PSD2 implementation into national law, *direct debits* started to have a positive impact on the number of licences in a given country. It can be explained by the fact that PayTechs’ managers may see opportunities in entering countries with widespread direct debit, as they can try to replace this old-fashioned means of payment.

5. Conclusion

The PayTech sector in Europe has grown significantly after the implementation of PSD2. In just the last two years (2018–2019), the number of obtained PayTech licences has increased fourfold. Complementing Europe’s bank-based system with Third Party Providers promises benefits and growth for the payments sector. However, the PayTech sector is still very small in comparison to the size of the traditional payments markets in Europe. The analysis shows that as many as 75% of the PSD2 licences were obtained by firms operating before the introduction of this regulation, and only a quarter of the licences were given to start-ups. Thus, in these first years, PSD2 had the greatest impact on the firms already operating on the market who were forced to obtain a new licence in order to comply with legal requirements to continue operating. It may also have been due to a desire to take advantage of regulatory changes and extend the scope of existing activities into payment services.

One of the main findings of the study is that following the adoption of PSD2 at the European level, the number of newly established start-ups, which eventually obtained a PayTech licence increased significantly compared to the control group. This brings quantitative evidence of the positive impact of PSD2 on the development of the PayTech sector in terms of promoting entrepreneurship. Therefore, there was above-average investor interest in entering the market and seizing the new market niche created by the PSD2 regulation. On the other hand, after the national transposition of PSD2 into individual member states’ legal systems, there was a decrease in the number of incorporated start-ups, although it still remained at a higher level than before the regulation was adopted. Thus, PSD2 appears to have been a stimulating regulatory shock that temporary, and the long-term. The long-term impact of PSD2 on the development of the PayTech sector in Europe will require further research which will become possible as the observation horizon extends.

The findings of this study indicate three main drivers of the number of PayTech licences granted in the EU. Firstly, the potential of the economy, measured by population and the popularity of online shopping, has a positive impact on the number of licences issued. Indeed, all five major EU economies have licensed a significant number of entities. However, despite the considerable market potential, some countries, like Germany and Italy, have not yet created conditions encouraging these businesses to provide cross-border services on a pan-European scale. This may change in the future and, having succeeded on a large local market, the PayTech entities operating in these two countries may commence their expansion. However, the results obtained showed that the positive impact of high market potential occurred before the adoption of PSD2.

Undoubtedly, a group of smaller countries, such as Lithuania, Malta, Cyprus, and Luxembourg, have already been successful in seizing the opportunity created by the PSD2 regulation. They made the strategic decision to build innovation hubs for PayTech start-ups with promising early results. Secondly, the authorities’ involvement in supporting PayTech development has proved to be a key factor in stimulating start-ups in a given country and attracting investors from other EU and non-EU countries. Research has shown that it is particularly effective to launch a regulatory sandbox which allows entities developing payment innovations to test them on the market with friendly financial supervision and support. Undoubtedly, the positive impact of the overall favourable climate for doing business in a given country cannot be underestimated either. Thirdly, and lastly, it was revealed that a country’s consumer habit of concluding cashless transactions with payment cards is an important driver for the growth of the PayTech sector, perhaps because many innovations are already based on the use of payment cards. Besides, cards have a very high share in e-commerce payments in most EU countries, and at the same time, this segment is also the main target market for PIS and AIS payment services introduced by PSD2. In the future, these groups of payment services may become direct competitors.

This work contributes to understanding the FinTech field both by (a) providing the evidence of the positive impact of PSD2 on the incorporations of PayTech start-ups, and by (b) proving that market potential, the differentiation of domestic payment systems, and the quality of the public environment for FinTech start-ups significantly affect the licensing of PayTech entities in Europe. However, the limitations of the study should also be considered, since the data analysed pertain to the *licences* for payment services, which only provides information about the *potential* of this activity. The actual number of registered users, the number of transactions concluded, and the income of these entities were not available at the time of the study.

The presented results can provide guidance for the authorities and EU regulators regarding the initial effects of PSD2 and the approach to PayTech licensing in Europe. Obtaining answers to these questions, at an early stage of PSD2 implementation, constitutes an opportunity to shape stable PayTech growth and high competitiveness of this sector. In contrast, late action could mean that the EU loses out to non-EU competitors and misses the opportunity to become the leader in payment innovations.

Moreover, it should be noticed that over 40% of the entire PayTech sector within the EU in 2019 was concentrated in the United Kingdom. It raises questions about the future of PayTech after Brexit. After the transitional period, since 2021, UK-registered entities will not be able to provide services within the EU. Therefore, significant changes can be expected in the PayTech sector concerning payment services providers' headquarters and subsidiaries locations in EEA countries.

The analysis has revealed that the issue of PayTech requires a number of future studies. Above all, it will be important to assess the longer-term impact of PSD2, including more comprehensive company data and longer time series. In addition, there is a need for qualitative and quantitative research on the functioning of particular types of PayTech licences, as well as research on the organisation and efficiency of regulatory sandboxes which have proven to be an important stimulus for PayTech development. The question about the role of payment card schemes in the changing landscape of open banking also remains.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table 6
Summary statistics.

Cross-country data (N = 28)	Mean	Median	Minimum	Maximum	Standard deviation	
Panel A: Time-invariant variables						
<i>PayTechs Before PSD2</i>	34.36	12.5	4	425	78.16	
<i>PayTechs Before National Law</i>	7.43	3.0	0	76	14.83	
<i>PayTechs After PSD2 Transposition</i>	4.89	0.5	0	71	13.68	
<i>Population</i>	18 220 781.21	9 265 478	450 415	82 175 684	23 620 381.28	
<i>GDP</i>	463 998.33	181 025.85	5 757.50	2 499 550.00	717 483.02	
<i>GDP per capita</i>	23 119.20	21 157.28	4 535.94	64 518.81	13 955.31	
<i>Internet purchase</i>	0.54	0.56	0.20	0.84	0.18	
<i>Innovation Hubs</i>	0.71	1.00	0.00	1.00	0.56	
<i>Sandbox</i>	0.30	0.00	0.00	1.00	0.47	
<i>Starting a business</i>	89.49	91.06	82.02	95.91	4.68	
<i>Card payments per capita</i>	141.16	92.30	18.30	366.10	100.76	
<i>Credit transfers per capita</i>	74.12	67.70	12.70	171.80	44.27	
<i>Direct debit per capita</i>	23.36	9.15	0.00	124.80	29.74	
<i>Cards issued per capita</i>	1.61	1.49	0.83	4.31	0.67	
<i>Instant payments</i>	0.14	0.00	0.00	1.00	0.36	
Years 2000–2018, monthly						
Number of incorporated companies: <i>Control group</i> (PSD2-licensed companies aggregated by country and month)		18.411	0.00	0.00	12 277.00	173.58
Number of incorporated companies: <i>Treatment group</i>		0.005	0.00	0.00	5.00	0.08
Panel B: Time-variant variables						

Table 7
Type of companies employed as the control group.

NACE Codes	Description	Number of companies incorporated 2000–2018
64.9	Other financial service activities, except insurance and pension funding	164,628
66.1	Activities auxiliary to financial services, except insurance and pension funding	265,798
62.0	Computer programming, consultancy and related activities	1349,418
82.9	Business support service activities n.e.c.	1284,259
64.1	Monetary intermediation	23,982
63.1	Data processing, hosting and related activities; web portals	172,022

Source: Orbis database (Bureau van Dijk, 2020).

Table 8
Correlation coefficients.

Variables	Institution	Inst_ Before_PSD2	Paytech_before_National_Law	PSD2_PAytech_After_National_Law	Internet purchase	Starting a business	Cards issued per capita	Credit transfer per capita	Direct debit per capita	Sandbox	Log (Population)
Institution	1	0.9910	0.9419	0.9619	0.4273	0.2414	0.2512	−0.0289	0.3610	0.3985	0.3715
Inst_ Before_PSD2		1	0.8959	0.9221	0.4375	0.2030	0.2600	−0.0259	0.3840	0.3691	0.4085
Paytech_before_National_Law			1	0.9757	0.3985	0.2938	0.2541	−0.0252	0.2756	0.4616	0.2055
PSD2_PAytech_ After_National_Law				1	0.3913	0.2986	0.2375	−0.2375	0.2971	0.4265	0.2765
Internet purchase					1	0.3400	0.4731	0.4946	0.5953	0.2751	0.2239
Starting a business						1	0.1688	0.2164	0.0427	0.1043	−0.1348
Cards issued p.c.							1	0.2574	0.3125	−0.0617	−0.2416
Credit transfer p.c.								1	0.0773	−0.0426	−0.0564
Direct debit p.c.									1	0.0773	0.5402
Sandbox										1	0.3018
Log(Population)											1

Correlation Coefficients, using the observations 1–28, 5% critical value (two-tailed) = 0.3739 for $n = 28$.

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