

## Research Article

# Consumer Savings and Digital Remittance in Open Banking: Insights From Bibliometric and Geospatial Econometric Analysis

**Ibrahim Niankara<sup>ID</sup>,<sup>1</sup> Hassan Ismail Hassan<sup>ID</sup>,<sup>2</sup> Rachidatou I. Traoret<sup>ID</sup>,<sup>3</sup>  
and Abu Reza Mohammad Islam<sup>ID</sup><sup>4</sup>**

<sup>1</sup>*College of Business, Al Ain University (AAU), Abu Dhabi, UAE*

<sup>2</sup>*Department of Finance & Banking, University Canada West (UCW), Vancouver, Canada*

<sup>3</sup>*Department of Statistics & Business Analytics, United Arab Emirates University (UAEU), Al Ain, UAE*

<sup>4</sup>*BRAC Business School, BRAC University, Dhaka, Bangladesh*

Correspondence should be addressed to Ibrahim Niankara; [ibrahim.niankara@aau.ac.ae](mailto:ibrahim.niankara@aau.ac.ae)

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Open banking (OB) refers to financial institutions opening their data and services to external parties via application programming interfaces (APIs), a practice that has been increasingly adopted globally since its 2018 regulatory inception in the United Kingdom. Despite its growth, there is still a lack of academic studies examining its impact on consumer financial behaviors on a global scale. This study addresses this gap by exploring OB's influence on consumers' formal saving and digital remittance behaviors worldwide. Using a mixed methods design, we combine bibliometric analysis and geospatial econometric modeling on Scopus OB bibliographic data and consumer financial preferences data from 2021 to 2022 across 139 countries. While the bibliometric results highlight the need for more international collaborations in OB research that reflect the ongoing collaborations in its implementation around the world, the econometric findings reveal significantly positive benefits for consumers globally, increasing the likelihood of formal saving and digital remittance. Specifically, consumers in countries with Revised Payment Services Directive (PSD2)-regulated initiatives, market-driven initiatives, and other non-PSD2 initiatives show higher marginal utilities (MUs) from digital remittance (39.1%–56.7%) compared to those in countries without OB initiatives. Additionally, consumers in PSD2 and market-driven countries exhibit higher MUs from formal saving by 61.8% and 37%, respectively, compared to those without OB initiatives. Overall, in addition to the implications for global open innovation, the paper provides reasonable evidence, supporting OB implementation to achieve several Sustainable Development Goals (SDGs) and the associated benefits to consumers' worldwide.

**JEL Classification:** C55; F30; F42; G20; G28; O33

**Keywords:** bibliometric analysis; digital remittance; financial inclusion; formal saving; geospatial econometrics; open banking

## 1. Introduction

The banking sector has undergone significant transformation propelled by technological advancements [1] and evolving consumer preferences [2]. A notable development in this evolution is the rise of open banking (OB), which traces its

origins to the early 2000s coinciding with the increasing prominence of digital banking solutions and application programming interfaces (APIs) [3]. These APIs facilitated seamless exchange of financial data, laying the groundwork for the emergence of OB [4, 5]. At its essence, OB entails financial institutions opening their data and services to

external parties through APIs [6], marking the onset of a new era in financial services and business models within the financial sector [7]. This transformation is driven by digital disruption, regulatory compliance [8], and competition from financial technology (fintech) firms [9].

Once regarded as disruptors, fintech firms are now seen as attractive partners for traditional banks [10], facilitating the outsourcing of key banking functions and enabling new market entrants [11]. For instance, Cortet et al. [12] highlighted the need for banks to adopt strategic initiatives in response to challenges posed by nonbank entities in the OB landscape, suggesting a roadmap for banks to secure their position as data custodians and establish trust in the digital market. Farrow [13], employing a feedback model of platform behavior, proposed platform models accommodating supply and demand-side solutions for OB while emphasizing the pivotal role of cloud technologies in ensuring the transactional dynamics and long-term viability of OB. Dratva [14] underscored the urgency for market players to engage in OB discussions, foreseeing substantial profits for banks if effectively implemented.

As a rapidly evolving phenomenon, OB is pursued based on its anticipated benefits [15]. Zukowsky [10], for instance, demonstrated that OB enhances consumer control over financial data and fosters collaboration between traditional financial institutions and fintech companies. Regulatory and market-driven OB initiatives worldwide are seen as transformative, creating new opportunities for individuals, small- and medium-sized enterprises (SMEs), banks, and third-party service providers (TPPs) [16]. For example, Yawe and Mukisa [17] highlighted the impact of the Revised Payment Services Directive (PSD2) in Europe on online payments, formalizing relationships between banks and fintechs and providing open access to customer account data and payment infrastructure. Farrow [18] proposed an API model framework for OB ecosystems, emphasizing value-added services beyond regulatory requirements. Passi [19] discussed the establishment of CBI Globe as an OB platform, facilitating interconnection between banks and third parties aligning with PSD2.

OB is credited with creating value and promoting financial inclusion [20] by expanding financial services to underserved individuals, reducing disparities, supporting SMEs, fostering global inclusion, and empowering vulnerable communities [21–24]. However, despite the global momentum behind OB initiatives, particularly catalyzed by the UK regulation in 2018 [25], followed by similar initiatives worldwide [26, 27], the actual impact of OB on consumer welfare remains understudied and inadequately documented [17]. Consequently, a significant gap exists in the scientific evidence validating the anticipated welfare benefits of OB for consumers globally.

This paper is aimed at filling this gap by examining consumers' digital financial behaviors, specifically formal saving and digital remittance choices, in the era of OB. Primarily focused on assessing the effectiveness of regulatory and market-driven OB initiatives worldwide, the study addresses the following research questions:

- i. What are the prevailing trends in the OB domain?
- ii. What is the status of consumers' demand for and access to formal savings and digital remittances in the context of OB?
- iii. Does a country's approach to OB (i.e., no OB initiative, regulatory PSD2 initiatives, other regulatory initiatives, market-driven initiatives) significantly influence domestic consumers' demand for and access to formal savings and digital remittances?

To address these questions, the study adopts a retrospective-prospective mixed methods design, integrating systematic knowledge domain visualization review through bibliometric-content analysis [28] and geospatial econometric modeling [29]. The bibliometric analysis utilizes data from Scopus following the Preferred Reporting Standards for Systematic Literature Review and Meta-Analysis (PRISMA) 2020 standard [30], while the geospatial econometric analysis employs consumer-stated financial preferences data from 139 countries with and without fully operational OB initiatives as of 2021–2022.

The subsequent sections of this paper are organized as follows: Section 2 offers a background overview of OB implementations worldwide; Section 3 delineates the adopted research methodology, including sampling and data collection design, as well as data analysis and modeling strategies; Section 4 presents the results, which are subsequently discussed in Section 5, along with the conclusion, implications, and future research suggestions

## 2. Background on OB Initiatives Around the World

The financial crisis of 2007–2008 prompted regulatory bodies to seek ways to increase transparency, competition, and innovation in the global financial sector [31]. In response, the UK's Competition and Markets Authority (CMA) recommended OB Standards to facilitate secure data sharing between banks and third-party providers [25]. This recommendation gained traction with the introduction of the PSD2 in the European Union (EU) in 2015, which mandated banks to provide access to customer transaction and personal data through secure APIs [19, 32].

The full implementation of PSD2 in 2018 marked a significant milestone in the global adoption of OB principles [33, 34]. Today, OB has evolved from a conceptual framework to a fully functional banking paradigm reshaping the global financial landscape [17, 22]. Evidence from the Open Banking Map indicates that more than 50 countries worldwide are actively discussing OB [35]. Nations with fully operational OB initiatives are broadly categorized as "market-driven" or "regulator-driven" countries.

The latter group of countries, where governments impose rules and requirements for OB, includes the United Kingdom, EU member states, Australia, Mexico, and Brazil. For instance, following the United Kingdom and the EU in 2018, Australia adopted a regulatory-driven approach in

2020, based on the Consumer Data Right (CDR) [36], while Mexico launched its initiative in the same year under the National Banking and Securities Commission (CNBV) and Fintech Law [35]. Brazil's OB initiative, driven by the Central Bank of Brazil (BCB) and the Open Banking Governance Structure (OBGS), was subsequently launched in 2021 [1, 37].

In contrast, market-driven countries, where industry players voluntarily agree on standards and practices for OB, include Singapore, Japan, Canada, New Zealand, and Switzerland. For example, Singapore, led by the Monetary Authority of Singapore (MAS) and the Association of Banks in Singapore (ABS), launched its OB initiative in 2016, becoming the first country to adopt a market-driven approach [38]. Similarly, Japan launched its initiative in 2018, followed by Canada and New Zealand in 2019 and Switzerland in 2020 [39–41].

Despite the proliferation of OB initiatives globally, empirical evaluations of their effectiveness remain limited. As nations refine their implementation strategies, rigorous empirical evidence is needed for informed decision-making and policy development. Therefore, in line with the research questions raised in the Introduction section, the next section describes the mixed methods design adopted for this study.

### 3. Methodology

**3.1. Sampling and Data Collection Design.** The study relies on two types of data sources: bibliographic data, which is collected from the Scopus database using the PRISMA 2020 standard, and stated financial preferences data extracted from the 2021–2022 World Banks' Global Findex surveys. The below subsections present the procedures followed to acquire the needed data.

**3.1.1. Bibliographic and Secondary Literature Data Sampling.** To ensure the selection of a systematic, comprehensive, and unbiased collection of relevant literature for the field visualization review, this study employed the PRISMA 2020 framework [30] to gather bibliographic data from the Scopus database. This choice was informed by Scopus being recognized as the world's largest repository of academic abstracts and citations, encompassing a wide array of content and subjects [42, 43]. Moreover, the increasing prevalence of studies utilizing Scopus-derived data in recent years underscores its growing acceptance among academic scholars [44–46].

Table A1 in the appendix delineates the search strategy and refinement protocol employed. As depicted, the initial search conducted on June 22, 2024, with end date of December 31, 2023, utilized the search term "open banking" in the "Title-Abs-Key" search tab within Scopus. This yielded 198 documents published between 1999 and 2023, as illustrated in Figure 1. Notably, prior to 2017, the annual frequency of published documents on "open banking" consistently registered as zero, with sporadic spikes observed in 1999, 2000, 2010, and 2014. However, upon preliminary assessment, these four earlier publications were deemed irrelevant to the research questions, resulting in their exclusion during

the selection phase. Consequently, the subsequent data selection comprised 194 documents published between 2016 and 2023, as summarized in Figure 2.

To uphold the review's quality and ensure data relevance to the research questions, the quality assessment stage involved further refinement based on specific inclusion and exclusion criteria. Restricting the subject area led to the exclusion of 8 documents, resulting in the inclusion of 186 documents spanning computer science, business, economics, social sciences, decision science, and engineering. Subsequent restrictions based on document type led to the exclusion of 35 documents, retaining 151 articles, conference papers, and reviews. Further refinement based on source type excluded 58 documents, leaving 93 journal articles for inclusion. Lastly, applying a language type restriction excluded 4 non-English journal articles, resulting in 89 qualifying journal articles published in English. The bibliographic data of these 89 journal articles were extracted into a single "csv" file for subsequent analysis using the R-based scientometric software, Bibliometrix [47].

**3.1.2. Secondary Survey Data Sampling.** Apart from the bibliographic and literature data sampled from Scopus, this study incorporates financial preference data obtained from the second update of the 2021–2022 World Bank Global Findex surveys [48]. Initially released by the World Bank on May 19, 2023, the original data was first published in October 2021, with an update in December 2022. The second and final update of the survey included data collected during the 2022 fiscal year from 16 additional countries not surveyed in the 2021 cycle. For a comprehensive understanding of the procedures and methodologies of the first wave of the survey, Niankara and Traoret [29] provide detailed information.

The raw data file was retrieved from the World Bank microdata library on July 17, 2023. It was processed and merged with geospatial metadata from the GADM library [49], along with information on national OB initiatives extracted from the OB data archives provided by Software AG [35]. After all data processing and merging, this research utilized a sample comprising 143,887 individual response data points for the 21 variables outlined in Table A3, which operationalize the conceptual framework presented in Figure 3, and the econometric model specifications in Equations (14) and (15). The geographical distribution of the study sample is depicted in Figure 4, while the summary statistics of all relevant variables are provided in Table A4.

### 3.2. Data Analysis and Modeling Strategy

**3.2.1. Bibliometric Analysis.** Implemented within the R-based scientometric software "Bibliometrix" [47], the bibliometric methods assess the productivity and impact (i.e., performance analysis) of the documents, academic journals, authors, affiliations, and countries, in addition to mapping the social structure, conceptual structure, and intellectual content of the OB knowledge space (i.e., science mapping).

**3.2.1.1. Descriptive Performance Analysis.** Here, "productivity" is assessed based on "the number of related publications" by

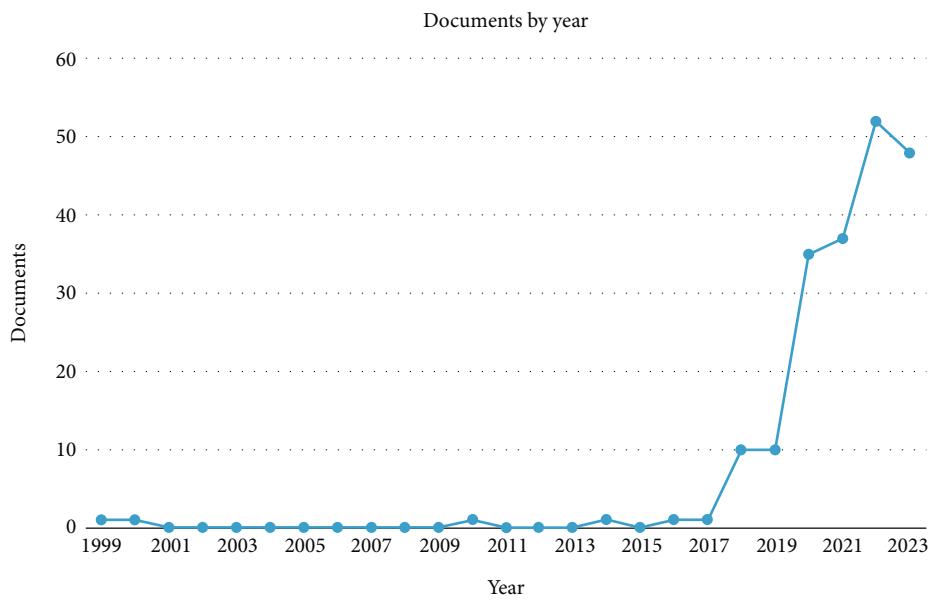


FIGURE 1: Distribution of documents from the initial search result.

Year ↓	Documents ↑
2023	48
2022	52
2021	37
2020	35
2019	10
2018	10
2017	1
2016	1

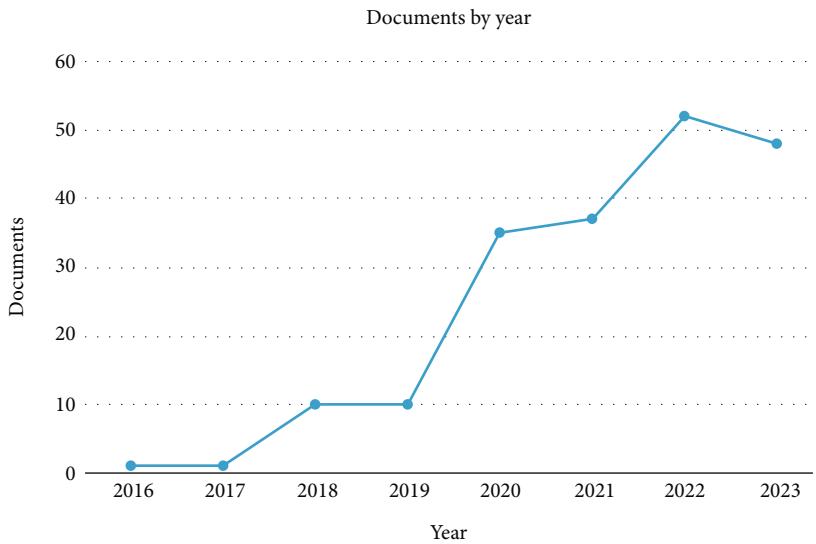


FIGURE 2: Distribution of documents following the selection stage.

the academic journals, authors, affiliations, and countries involved in the OB knowledge space, while “impact” is assessed using “the number of received citations” by the academic journals, authors, affiliations, and countries involved in the OB knowledge space. Together, the productivity and impact performances combine to define the “most relevant” academic journals, authors, affiliations, and countries involved in the OB knowledge space.

**3.2.1.2. Science Mapping.** This dimension of the implemented bibliometric analysis uncovers the social structure, conceptual structure, and intellectual content of the OB knowledge space. The social structure is evaluated graphically using the country collaboration map that represents

the network of collaborating authors from different countries. The conceptual structure is also graphically evaluated using the thematic map of the OB knowledge space. The intellectual content of the OB knowledge space is evaluated through literature classification and critical content review.

### 3.2.2. Spatial Econometric Modeling

**3.2.2.1. The Conceptual Framework.** Within the framework of random utility theory [50], the conceptual model delineating the influence of national-level online banking approaches (OBApps) on domestic consumers’ preferences for banking services, namely, formal saving and digital remittance choices, is presented in Figure 3.

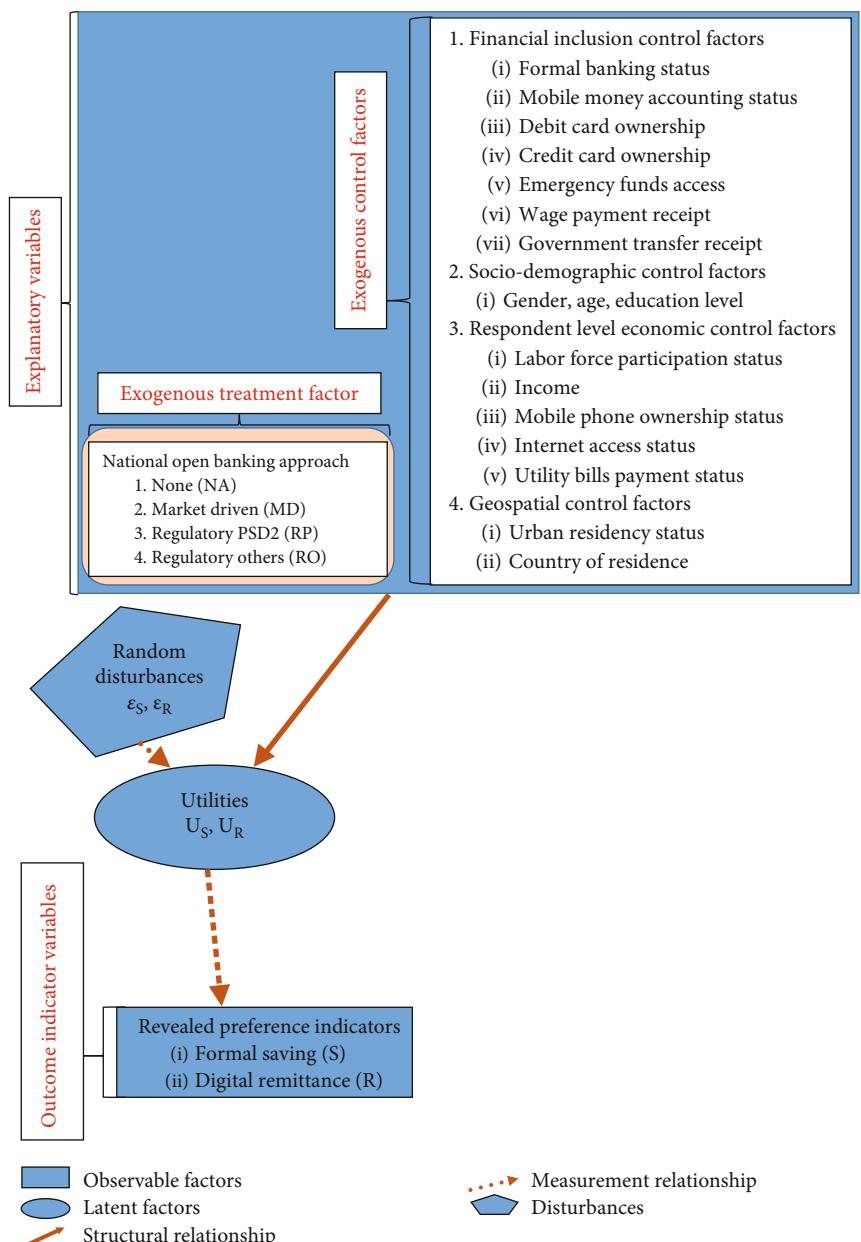


FIGURE 3: Conceptual framework based on random utility theory illustrating the impact of national-level open banking approaches on domestic consumers' preferences for banking services (i.e., formal saving and digital remittance).

The framework posits that the preference of the representative consumer for each banking service is determined by its perceived utility. Consequently, the representative consumer will opt to engage in formal saving (i.e., depositing money in an interest-bearing account with a formal financial institution) and/or digital remittance (i.e., using a mobile phone or the internet to send money to family or friends) only if the utility derived from such actions surpasses that of abstaining (i.e., if the marginal utility (MU) derived from formal saving and/or digital remittance is positive). Otherwise, the representative consumer will choose not to utilize these banking services. Furthermore, the framework assumes that the subjective utility experienced by the representative consumer is contingent upon the national-level

OBApp adopted (i.e., whether there is no OB initiative, regulatory PSD2 initiatives, other regulatory initiatives, or market-driven initiatives), alongside various financial, economic, social, demographic, and geospatial control factors, as well as unobserved factors.

The objective is to dissect the comprehensive impact of the multilevel treatment factor representing the national OBApp on the financial preferences/behaviors of the representative consumer, while mitigating the influence of other pertinent factors shaping consumers' financial behaviors.

**3.2.2. Algebraic Operationalization of the Graphical Conceptual Framework.** In order to express the graphical conceptual framework in algebraic terms, this study employs

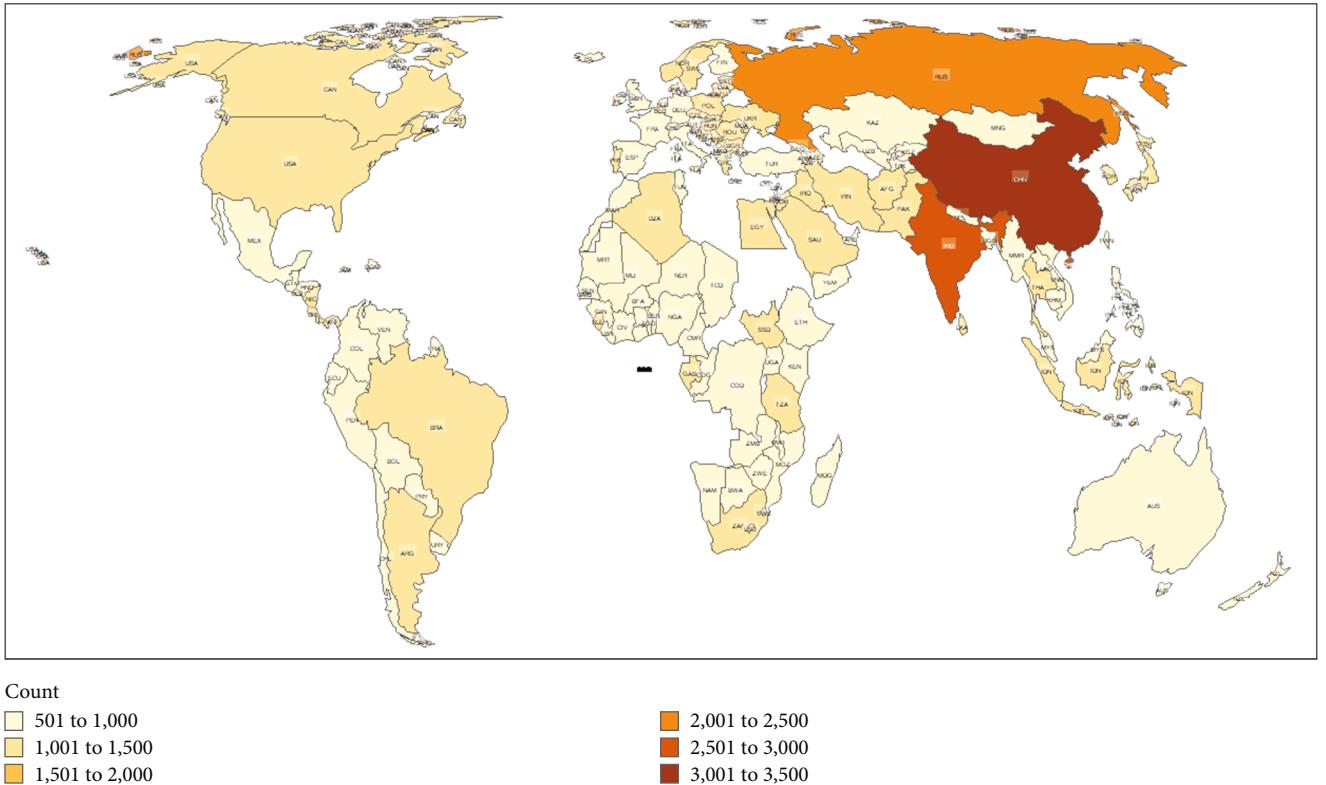


FIGURE 4: Respondents' frequency count across the 139 countries in the study sample. Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

additive random utility modeling [51] to depict the bivariate function of formal saving ( $S$ ) and digital remittance ( $R$ ) within the era of OB as

$$\begin{cases} U_S^* = V_S + \varepsilon_S \\ U_{\bar{S}}^* = V_{\bar{S}} + \varepsilon_{\bar{S}} \\ U_R^* = V_R + \varepsilon_R \\ U_{\bar{R}}^* = V_{\bar{R}} + \varepsilon_{\bar{R}} \end{cases} \quad (1)$$

where the representative consumer's formal saving decision is characterized by "S" if (s)he chooses to formally save money at a financial institution and " $\bar{S}$ " if (s)he chooses not to. Similarly, the digital remittance decision is characterized by "R" if (s)he chooses to digitally remit during the year and  $\bar{R}$  if (s)he chooses not to remit.

As demonstrated in Equation (1), the terms  $V_S$ ,  $V_{\bar{S}}$ ,  $V_R$ , and  $V_{\bar{R}}$  represent the nonrandom or systematic components of utility, while  $\varepsilon_S$ ,  $\varepsilon_{\bar{S}}$ ,  $\varepsilon_R$ , and  $\varepsilon_{\bar{R}}$  represent the random or unobserved components. These two components, systematic and unobserved, combine to yield latent utility outcomes. Although not directly observable, the status of these latent utilities is inferred from the observed indicators of formal saving and digital remittance choices, as outlined by the following relationships:

$$D_1 = \begin{cases} S & \text{if } U_S^* - U_{\bar{S}}^* > 0, \\ \bar{S} & \text{otherwise,} \end{cases} \quad (2)$$

$$D_2 = \begin{cases} R & \text{if } U_R^* - U_{\bar{R}}^* > 0, \\ \bar{R} & \text{Otherwise.} \end{cases}$$

Given that each choice situation is dichotomous, the equations in Equation (2) can be rephrased as

$$D_1 = \begin{cases} 1 & \text{if } U_S^* - U_{\bar{S}}^* > 0, \\ 0 & \text{otherwise.} \end{cases} \quad (3)$$

$$D_2 = \begin{cases} 1 & \text{if } U_R^* - U_{\bar{R}}^* > 0, \\ 0 & \text{Otherwise.} \end{cases}$$

Hence, facilitating the expression of the marginal probabilities that the representative consumer engages in formal saving and/or digital remittance as

$$\begin{aligned} P[D_1 = 1] &= P[U_S^* - U_{\bar{S}}^* > 0], \\ P[D_2 = 1] &= P[U_R^* - U_{\bar{R}}^* > 0]. \end{aligned} \quad (4)$$

In other words, the likelihood of engaging in formal saving ( $D_1 = 1$ ) is equivalent to the likelihood that the random utility linked with formal saving surpasses that of not saving ( $U_S^* - U_{\bar{S}}^* > 0$ ). Likewise, the likelihood of conducting digital

remittances ( $D_2 = 1$ ) is akin to the likelihood that the random utility linked with digital remittance surpasses that of not remitting ( $U_S^* - U_{\bar{R}}^* > 0$ ).

Focusing initially on solving the representative consumer's formal saving decision, we get:

$$\begin{aligned} P[U_S^* - U_{\bar{S}}^* > 0] &= P[(V_S + \varepsilon_S) - (V_{\bar{S}} + \varepsilon_{\bar{S}}) > 0] \\ &= P[(\varepsilon_S - \varepsilon_{\bar{S}}) > (V_{\bar{S}} - V_S)] \\ &= P[(\varepsilon_{\bar{S}} - \varepsilon_S) < -(V_{\bar{S}} - V_S)]. \end{aligned} \quad (5)$$

Similarly, the representative consumer's digital remittance decision is given by

$$\begin{aligned} P[U_R^* - U_{\bar{R}}^* > 0] &= P[(V_R + \varepsilon_R) - (V_{\bar{R}} + \varepsilon_{\bar{R}}) > 0] \\ &= P[(\varepsilon_R - \varepsilon_{\bar{R}}) > (V_{\bar{R}} - V_R)] \\ &= P[(\varepsilon_{\bar{R}} - \varepsilon_R) < -(V_{\bar{R}} - V_R)]. \end{aligned} \quad (6)$$

Further using the following notational simplifications<sup>1</sup>,

$$\begin{aligned} V_{\bar{S}} - V_S &= \tilde{V}_S \quad \text{and} \quad \varepsilon_{\bar{S}} - \varepsilon_S = \tilde{\varepsilon}_S, \\ V_{\bar{R}} - V_R &= \tilde{V}_R \quad \text{and} \quad \varepsilon_{\bar{R}} - \varepsilon_R = \tilde{\varepsilon}_R. \end{aligned} \quad (7)$$

We derive  $\tilde{V}_S$  as the observable change in the total utility experienced by the representative consumer due to the decision to save money formally at a financial institution, which is alternatively the consumer's observed MU from formal saving. Similarly, the expression  $\tilde{V}_R$  signifies the representative consumer's observed MU from digitally remitting. Conversely, the terms  $\tilde{\varepsilon}_S$  and  $\tilde{\varepsilon}_R$ , respectively, denote the unobserved MUs derived by the representative consumer from formal saving and digital remittance. Consequently, the representations of marginal probabilities in Equations (5) and (6) can be more succinctly articulated as

$$P[D_1 = 1] = P[\tilde{\varepsilon}_S < -\tilde{V}_S] = \int_{-\infty}^{-\tilde{V}_S} f(\tilde{\varepsilon}_S) d\tilde{\varepsilon}_S, \quad (8)$$

$$P[D_2 = 1] = P[\tilde{\varepsilon}_R < -\tilde{V}_R] = \int_{-\infty}^{-\tilde{V}_R} f(\tilde{\varepsilon}_R) d\tilde{\varepsilon}_R. \quad (9)$$

The marginal probability formulations above presuppose the mutual independence of the representative consumer's choices regarding formal saving and digital remittance. However, this independence is not invariably obligatory in reality. To account for the potential interdependence of these decisions within and among individual consumers in the global economy, we relax this assumption. Consequently, we arrive at the subsequent bivariate probability distribution:

$$P[D_1 = 1, D_2 = 1] = \int_{-\infty}^{-\tilde{V}_S} \int_{-\infty}^{-\tilde{V}_R} f(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R) d\tilde{\varepsilon}_S d\tilde{\varepsilon}_R \quad (10)$$

where  $f(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R)$  represents the general form of the bivariate density function describing the unobserved/random MUs  $\tilde{\varepsilon}_S$  and  $\tilde{\varepsilon}_R$ , which is utilized to delineate the combined likeli-

hood of formal saving and digital remittance in the era of OB. From a behavioral economics standpoint, this overarching bivariate density function offers alternative behavioral models contingent upon the type of distributional assumptions imposed on  $f(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R)$ . For instance, the bivariate logit model, predicated on the assumption that the error density adheres to the standard logistic distribution, emerges when  $f(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R) = \Lambda_2(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R)$ , whereas the bivariate probit model, assuming a standard normal error distribution, ensues from  $f(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R) = \Phi_2(\tilde{\varepsilon}_S, \tilde{\varepsilon}_R)$ . In either scenario, the resulting behavioral economic model entails a bivariate variance–covariance matrix for the joint likelihood function in Equation (10) of the general format:

$$\Sigma = \begin{bmatrix} \theta_{SS} & \theta_{SR} \\ & \theta_{RR} \end{bmatrix} \quad (11)$$

where  $\theta_{SS}$  and  $\theta_{RR}$  represent the global variations (variances) in consumers' choices regarding formal saving and digital remittance in the era of OB. Meanwhile,  $\theta_{SR}$  denotes the covariance between formal saving and digital remittance choices in this period. By adopting the standard identification restriction that sets the variance parameters of Equation (11) to one (i.e.,  $\theta_{SS} = \theta_{RR} = 1$ ), the covariance parameter  $\theta_{SR}$  is estimated alongside the unknown parameters  $\beta_{ij}$  in Equations (12) and (13). In the present formulation of the additive random utility model concerning formal saving and digital remittance choices in the era of OB, the explicit forms of the observed MU functions  $\tilde{V}_S$  and  $\tilde{V}_R$  are, respectively,

$$\begin{aligned} \tilde{V}_S &= \beta_{10} + \beta_{11} \text{OBApp} + \beta_{12} \text{account}_{fin} \\ &\quad + \beta_{13} \text{MobMoneyAcc} + \beta_{14} \text{DebCard} \\ &\quad + \beta_{15} \text{CredCard} + \beta_{16} \text{EmerFundAcesDif} \\ &\quad + \beta_{17} \text{WagPaiRec12m} + \beta_{18} \text{GovTransf12m} \\ &\quad + \beta_{19} \text{female} + \beta_{110} \text{educLev} + \beta_{111} \text{InLaborForce} \\ &\quad + \beta_{112} \text{income}_q + \beta_{113} \text{mobileown} + \beta_{114} \text{internAcces} \\ &\quad + \beta_{115} \text{UtBillsPaid12m} + \beta_{116} \text{UrbanStat} + \beta_{117} \text{age} \\ &\quad + \beta_{118} \text{country}, \end{aligned} \quad (12)$$

$$\begin{aligned} \tilde{V}_R &= \beta_{20} + \beta_{21} \text{OBApp} + \beta_{22} \text{account}_{fin} \\ &\quad + \beta_{23} \text{MobMoneyAcc} + \beta_{24} \text{DebCard} \\ &\quad + \beta_{25} \text{CredCard} + \beta_{26} \text{EmerFundAcesDif} \\ &\quad + \beta_{27} \text{WagPaiRec12m} + \beta_{28} \text{GovTransf12m} \\ &\quad + \beta_{29} \text{female} + \beta_{210} \text{educLev} + \beta_{211} \text{InLaborForce} \\ &\quad + \beta_{212} \text{income}_q + \beta_{213} \text{mobileown} + \beta_{214} \text{internAcces} \\ &\quad + \beta_{215} \text{UtBillsPaid12m} + \beta_{216} \text{UrbanStat} + \beta_{217} \text{age} \\ &\quad + \beta_{218} \text{country}. \end{aligned} \quad (13)$$

In Equations (12) and (13) as currently depicted, age and country-specific factors are presumed to exert linear additive

effects ( $\beta_{117}, \beta_{217}$ ) and ( $\beta_{118}, \beta_{218}$ ) on the observed MUs derived from formal saving and digital remittance. To relax the linearity assumption associated with these factors further, permitting them to influence the functional forms of Equations (12) and (13) nonlinearly, we derive the subsequent semiparametric (or partially linear) observed MU functions:

$$\begin{aligned}\tilde{V}_S = & \beta_{10} + \beta_{11} \text{OBApp} + \beta_{12} \text{account}_{\text{fin}} \\ & + \beta_{13} \text{MobMoneyAcc} + \beta_{14} \text{DebCard} \\ & + \beta_{15} \text{CredCard} + \beta_{16} \text{EmerFundAcesDif} \\ & + \beta_{17} \text{WagPaiRec12m} + \beta_{18} \text{GovTransf12m} \\ & + \beta_{19} \text{female} + \beta_{110} \text{educLev} + \beta_{111} \text{InLaborForce} \\ & + \beta_{112} \text{income}_q + \beta_{113} \text{mobileown} + \beta_{114} \text{internAcces} \\ & + \beta_{115} \text{UtBillsPaid12m} + \beta_{116} \text{UrbanStat} + g_{11}(\text{age}) \\ & + g_{12}(\text{country}),\end{aligned}\quad (14)$$

$$\begin{aligned}\tilde{V}_R = & \beta_{20} + \beta_{21} \text{OBApp} + \beta_{22} \text{account}_{\text{fin}} \\ & + \beta_{23} \text{MobMoneyAcc} + \beta_{24} \text{DebCard} \\ & + \beta_{25} \text{CredCard} + \beta_{26} \text{EmerFundAcesDif} \\ & + \beta_{27} \text{WagPaiRec12m} + \beta_{28} \text{GovTransf12m} \\ & + \beta_{29} \text{female} + \beta_{210} \text{educLev} + \beta_{211} \text{InLaborForce} \\ & + \beta_{212} \text{income}_q + \beta_{213} \text{mobileown} + \beta_{214} \text{internAcces} \\ & + \beta_{215} \text{UtBillsPaid12m} + \beta_{216} \text{UrbanStat} + g_{21}(\text{age}) \\ & + g_{22}(\text{country}).\end{aligned}\quad (15)$$

The coefficient parameters  $\beta_{ij}$  represent the unknown factors that linearly influence the observed MUs of the representative consumer's formal banking and digital remitting activities in the era of OB. Conversely,  $g_{11}$  and  $g_{21}$  denote the unknown functional forms of the nonlinear effects of the consumer's age on the observed MUs derived from formal banking and digital remitting, respectively, in the OB era. Likewise,  $g_{12}$  and  $g_{22}$  are the unknown nonlinear spatial (i.e., random country) effects, capturing the impacts of all country level factors (e.g., macroeconomic, national policy mix, cultural) influencing the observed MUs consumers' derive, respectively, from formal banking and digital remitting in the era of OB. Of particular interest in this study are  $\beta_{11}$  and  $\beta_{22}$ , which depict the conditional impacts of each country's adopted OBApp on the MU that its representative consumer derives from formal saving and digital remitting, respectively.

The unbiased estimation of the linear and nonlinear parameters of the complete spatial econometric model is accomplished using semiparametric bivariate estimators (probit and logit), as outlined in Wojtys et al. [52]. These estimators rely on the trust region iteration algorithm. All estimations are conducted within the R statistical package [53], Version 6.3.1. Further details on the required penalized

maximum likelihood-based estimator can be found in the R library "GJRM" for interested readers.

**3.2.2.3. Validation of the Spatial Econometric Models.** To ensure the statistical integrity of the spatial econometric models and validate the conceptual framework depicted in Figure 3, a series of statistical tests is employed.

Initially, to assess the interrelationship between the two endogenous indicators, namely, formal saving (SavBkAccFinInst12M) and digital remittance (DigitRemitt), and their qualitative exogenous drivers as shown in Figure 3, the chi-squared dependence testing procedure is utilized. This procedure, conducted within the R statistical software, employs the base function "chisq.test()" from the "stats" library [53]. It implements a Pearson's chi-squared test with Yates' continuity correction, operating under the null hypothesis of independence between the two factors. The resulting  $p$  value guides statistical decision-making, with significance determined at the 5% level or lower.

Conversely, to evaluate the dependency link between the endogenous indicators (SavBkAccFinInst12M and DigitRemitt) and the quantitative exogenous driver "age," Welch's means testing procedure is employed, along with Levine's variances homogeneity testing. These tests are executed within R using the respective functions "leveneTest()" and "t.test()" from the "car" library [54]. Detailed significance information is provided in Tables A6 and A7.

The outcomes of the chi-squared testing procedure, illustrated in Table A5, offer robust support (as evidenced by all  $p$  values  $< 1\%$  alpha level) for the significant interdependence between the endogenous indicators (SavBkAccFinInst12M and DigitRemitt). Moreover, they confirm the significant dependence of these indicators on all qualitative exogenous drivers in Figure 3, including the factor representing the adopted OBApp.

Similarly, the results of Levine's variance homogeneity tests in Table A6, coupled with those of Welch's means testing in Table A7, corroborate the significant dependence of the endogenous indicators (SavBkAccFinInst12M and DigitRemitt) on the "age" variable. These numerical findings align with the graphical insights from the boxplots in Figure 5, where it is visually apparent that the median age of reported remittance senders is lower than that of individuals not engaging in digital remittance over the preceding 12 months. Conversely, the median age of those reporting formal saving is higher compared to those not involved in formal saving during the same period. Collectively, these numerical and graphical findings indicate that the financial choices made by individual consumers regarding formal saving and digital remittance throughout the year significantly correlate with their age.

In addition to the aforementioned dependency link testing, the assessment of the joint likelihood function's validity, which signifies the bivariate specification assumption in the data generating process, is conducted using the Lagrange multiplier test. This test relies on the "LM.bpm()" function from the R library "GJRM." Under the null hypothesis of independent binary processes, this test generates a  $p$  value, compared against the standard alpha significance level of

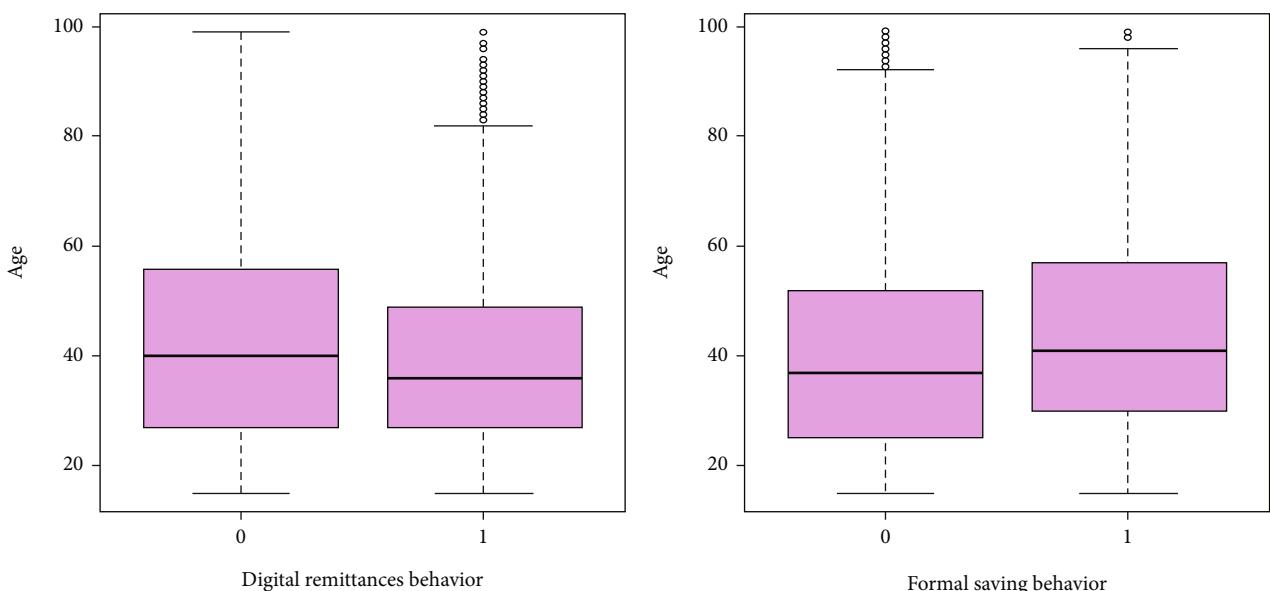


FIGURE 5: Boxplots of the quantitative explanatory factor “age,” against the two endogenous indicators of digital remittance and formal saving behaviors.

5% for statistical decision-making. Alternatively, the bivariate specification assumption can be tested by examining the statistical significance of the 95% confidence interval on the dependence parameter (or covariance)  $\hat{\theta}_{SR}$  derived from the estimated model. If the confidence interval excludes zero, it supports the joint/bivariate specification; otherwise, the univariate specification is deemed more valid.

The Lagrange multiplier test yielded a  $p$  value of  $1.877 \times 10^{-150}$ , significantly below the 5% alpha level, providing ample evidence to reject the null hypothesis of independence. Consequently, it is concluded that there is a significant correlation between the formal saving and digital remitting processes of individual consumers in the OB era. This conclusion is further reinforced by the evidence from the estimated covariance (or dependence) parameter  $\hat{\theta}_{SR}$  presented in Table A8. Notably, both the spatial parametric specification and the spatial semiparametric specification reveal that the 95% confidence intervals’ estimated values do not include zero, confirming the substantial interdependence between the two processes at  $\hat{\theta}_{SR} = 0.16$ . These latter results affirm the appropriateness of the joint bivariate model for formal saving and digital remittance behaviors over any alternative independent binary specification of the system.

In summary, the outcomes of this subsection support the statistical validity of the spatial bivariate econometric model, which operationalizes the conceptual framework in Figure 3. Therefore, the subsequent subsection will focus on testing its reliability.

**3.2.2.4. Sensitivity Analysis of the Spatial Econometric Models.** To ensure the reliability of the estimated findings from the econometric model and their resistance to misspecification bias, the spatial estimators described in Wojtys et al. [52] are applied under the probit specification of the error term. The outcomes of these two estimators are

summarized in Table A8, illustrating the coefficient estimates of the driving factors influencing consumers’ MU to formally save and digitally remit in the OB era.

Comparing the performance of the two estimators based on the convergence criteria of the algorithm and the model performance indicators presented at the bottom of Table A8, it is evident that both variants of the implemented trust region iteration algorithm (fully parametric and semiparametric) exhibit successful convergence. This is evidenced by their largest absolute gradients and eigenvalue ranges. Moreover, the consistency in terms of the sign, significance, and magnitude of the estimated coefficients across the spatial estimators (parametric and semiparametric) suggests the robustness of the empirical findings against model misspecification. In essence, the specified econometric model is considered dependable.

**3.2.2.5. Selection of the Optimal Model Specification.** In order to select the most optimal model specification, the performances of two specifications are compared, taking into account the established validity and reliability of the econometric model. The contrast is made based on the information criteria of Akaike (AIC) and Bayes (BIC). In comparison to its spatial parametric counterpart, which yields  $AIC = 214680.6$  and  $BIC = 217812.5$ , the spatial semiparametric estimator demonstrates superior in-sample properties with lower values of both  $AIC = 214484.9$  and  $BIC = 217709.0$ .

Supporting this conclusion from the AIC and BIC criteria, the outcomes of subsequent likelihood ratio tests by Vuong [55] and Clarke [56] are considered. These tests utilize the Kullback–Leibler information criterion and are suitable statistical procedures for comparing nonnested bivariate models through ratios of their likelihood functions. While the Vuong test is aimed at determining which model is closer to the actual (or true) model, the Clarke test assesses

the equivalence between the competing models. Implemented here using the “VuongClarke()” function from the R library “GJRM,” both tests identified the spatial semiparametric model specification as the best-performing candidate. Therefore, the results in the following section are presented based on the outcome of this preferred model specification.

## 4. Results

**4.1. Descriptive Bibliometric Results.** Descriptive bibliometric findings of the OB dataset extracted from Scopus are outlined in Figure 6. Utilizing the Bibliometrix software, this visualization illustrates the publication timeframe spanning from 2016 to 2023 within the OB knowledge domain. Since 2016, a total of 89 research articles have been published in the OB research field, drawing from 4075 references and 303 author-provided keywords, involving 204 authors, with 19 single-authored publications. The average age of these 89 documents is 2.55 years, with an average citation count of 8.326 per document and an international coauthorship rate of 11.24%, equating to 2.48 coauthors per document. These statistics, coupled with the 59.27% annual growth rate and the frequency distribution depicted in Figure 2, signify a recent yet substantial and expanding interest in OB research within the international scholarly community.

Apart from the aforementioned trends, the application of “Bradford’s law” to the examined bibliographic dataset resulted in the primary source distribution as depicted in Figure 7. Bradford’s law, a principle elucidating the uneven distribution of sources in a given subject area, delineates the literature into distinct zones. In fields like OB research, this law suggests that the literature can be categorized into zones: the first zone comprises a small number of core or highly prolific sources that yield a substantial number of published articles in the field. The second zone encompasses a larger number of sources contributing moderately to the literature, while the third zone comprises numerous sources, each making minimal contributions to publications and therefore typically regarded as less pertinent to the field.

Figure 7 illustrates that the core of the OB knowledge domain comprises seven scholarly journals, representing the most significant sources of OB knowledge in academic literature. These include the *Journal of Payments Strategy and Systems*, the *Journal of Risk and Financial Management*, the *European Business Law Review*, *Applied Sciences (Switzerland)*, *Banking Law Journal*, *Financial Innovation*, and *Future Generation Computer Systems*. Additionally, among the top 10 most relevant sources in the OB knowledge domain are *Future Internet*, the *International Journal of Bank Marketing*, and *Wireless Communications and Mobile Computing*, all of which fall into the second zone according to Bradford’s law. Hence, it can be inferred that the OB knowledge domain enjoys a diverse coverage of sources from various disciplines, including business (such as accounting, management, and marketing), law, information systems, computer science, and multidisciplinary studies.

In addition to the aforementioned coverage of sources within the OB knowledge domain, Figure 8 illustrates the top 10 most relevant authors and their dynamic productivity

and impact over time. Notably, Borgogno emerges as the most prolific author, having contributed three research articles to the OB research field since 2020, followed by Hjelkrem with two contributions and, finally, Nessel with one publication in 2022. Furthermore, Figure 9 identifies the top 10 most relevant academic institutions contributing to the OB knowledge domain. Topping this list is the Norwegian University of Science and Technology with eight publications to date, followed by the Pontifical Catholic University of Rio de Janeiro with five publications and subsequently Dublin City University and Fudan University, each with four publications in the OB knowledge domain.

Furthermore, Figure 10 highlights the top 20 most relevant corresponding authors’ countries based on both single-country and multiple-country OB research contributions. Notably, Italy, the United Kingdom, Norway, Brazil, China, India, Poland, Spain, Australia, and Egypt host the top 10 most relevant corresponding authors in the OB knowledge domain. However, cross-country collaborative contributions are evident in only four of the top 20 most relevant countries, indicating potential for increased international collaborations within the OB knowledge space. This observation aligns with the cross-country collaboration map illustrated in Figure 11. Indeed, international collaborations in OB coauthorship appear limited, with examples including Australia and Germany, Australia and Hong Kong, the United Kingdom and Italy, Norway and Saudi Arabia, and Spain and the Netherlands, underscoring the opportunity for enhanced collaborative endeavors among scholars from diverse countries with differing OBApps.

Moving toward comprehending the conceptual framework of the OB knowledge domain, Figure 12 presents a tree map illustrating the most significant author-provided keywords. Notably, “open banking” emerges as the predominant keyword, used by authors approximately 24% of the time. It is followed by “fintech,” employed 12% of the time, then “PSD2” around 7% of the time, and “regulation” utilized about 2% of the time, among others. These findings align with the dynamic trends analysis depicted in Figure 13. Beginning in 2020, the prominence of the “PSD2” topic increased, followed by a surge in the frequency of “blockchain,” “fintech,” and “open banking” in 2022. As of 2023, “data sharing” has emerged as a notable topic in the OB knowledge space. Further delineating the conceptual framework of the OB knowledge domain is the coword network map in Figure 14, which identifies five thematic clusters of development in the OB knowledge domain. The foremost themes revolve around the “open banking” node (green colored network) and the “fintech” node (red colored network).

Before delving into the intellectual landscape of the OB knowledge domain in the subsequent section, via literature classification and critical assessment, Table A2 provides a summary of the top 30 globally impactful publications related to OB. Utilizing citation count as a measure of impact, “ZETZSCHE DA, 2020, J FINANC REGUL” emerges as the most influential article in the OB knowledge space, with a total of 103 citations recorded in November 2023, averaging 25.75 citations per year [57]. Similarly, Table A2 highlights “NANAEVA Z, 2021, J PAYM

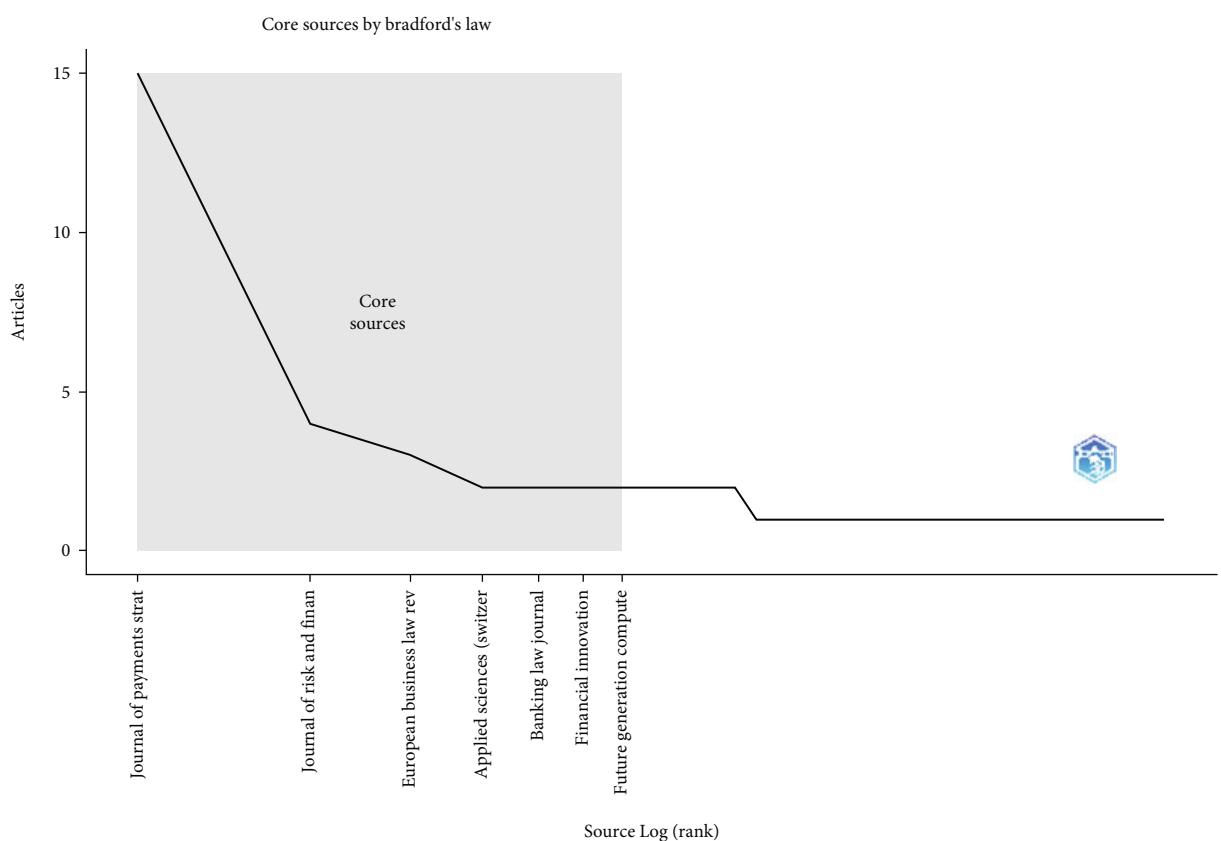


FIGURE 7: The core sources (academic journals) in the open banking knowledge space, by Bradford's law.

STRATEG SYST" as the 30th most impactful article in the OB knowledge space [33].

**4.2. Literature Classification and Critical Content Review.** The intellectual landscape of the OB knowledge space, characterized by 89 documents, reflects a rich tapestry of sources, authors, and academic disciplines contributing to its evolution. A myriad of perspectives and research methodologies has been employed by scholars to explore OB, as classified and evaluated in the ensuing subsections.

**4.2.1. Studies of OB Security Challenges and Solutions.** Security and trust play pivotal roles in the adoption of new technological paradigms by consumers [58], a notion extensively explored within the OB context. For instance, Kassab and Laplante [59] define OB as a financial ecosystem necessitating specialized security protocols and stakeholder guidelines, highlighting trust's significance. Kellezi et al. [60] address resultant security challenges postimplementation of PSD2 regulation by developing an innovative web solution employing the model-view-controller architecture, enhancing user savings behavior and positive habits. Alves et al. [61] propose a

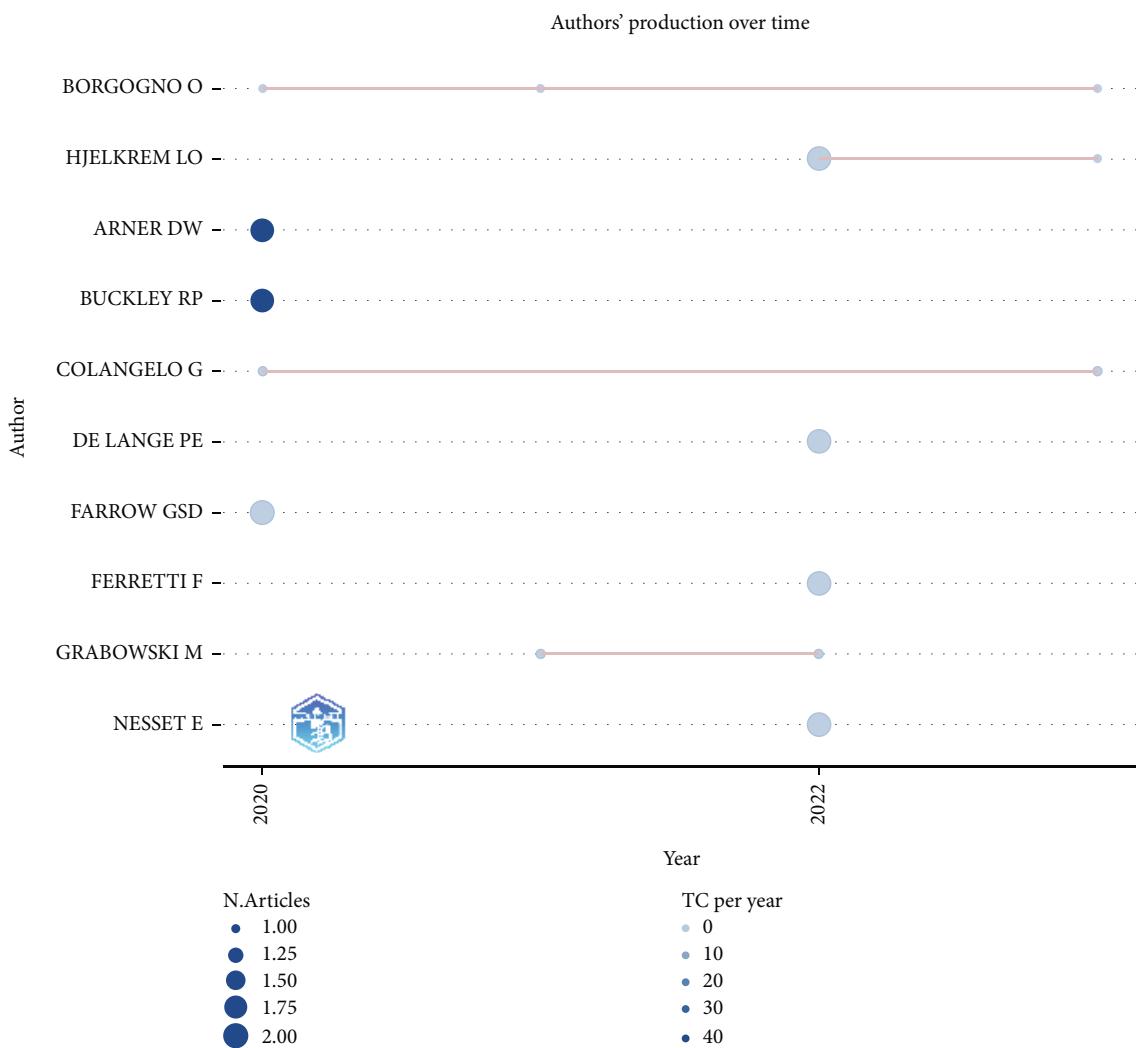


FIGURE 8: Top 10 most relevant authors in the open banking knowledge space.

normative multiagent system to tackle challenges related to personal data protection regulation and information asymmetry in OB, capturing agents' preferences and concerns. Ahmed et al. [62] introduce a blockchain-based self-sovereign banking identity (SSBI) framework to balance customer experience, security, and self-control over personal identity information in the realm of open finance and banking. This framework utilizes customers' banking cards for secure OB data sharing, emphasizing the need for scalability and enhancement before real-world implementation.

Similarly, Norimatsu et al. [63] focus on challenges encountered by authorization servers in addressing distinct client requests' security profiles, particularly in OB scenarios. They propose a policy-based approach, leveraging policies and client request context to determine security profiles, thus allowing one authorization server to support multiple security profiles without necessitating multiple servers or isolated environments. Ko et al. [64] address security challenges in non-face-to-face transactions, proposing a blockchain-based non-face-to-face P2P real-time token payment system to ensure secure online transactions amidst the

rise in intelligent voice phishing and reliance on OB systems. Liao et al. [65] present a blockchain-based identity management and access control framework, BIMAC, utilizing smart contracts and stateless authentication to integrate decentralized applications (DApps) into OB for service innovation while addressing digital identity, data sharing, privacy, and trust issues. Riad and Elhoseny [66] describe smart contract functions on the Ethereum platform addressing data privacy challenges in OB and evaluating the proposed scheme's efficiency and security against known attacks.

In a similar vein, Wang et al. [67] propose a blockchain-based data privacy management framework to address challenges in data privacy protection posed by OB, validated through field and laboratory experiments. Zu et al. [68] develop E-SAWM, a dynamic watermarking service framework, for securing open fixed-layout documents (OFD) in edge cloud scenarios, effectively addressing concerns related to data security in OFD files. Zilnieks and Erins [15] explore opportunities and challenges in integrating decentralized payment systems in e-commerce, proposing a sample model using distributed ledger technology, while Adams et al. [69]

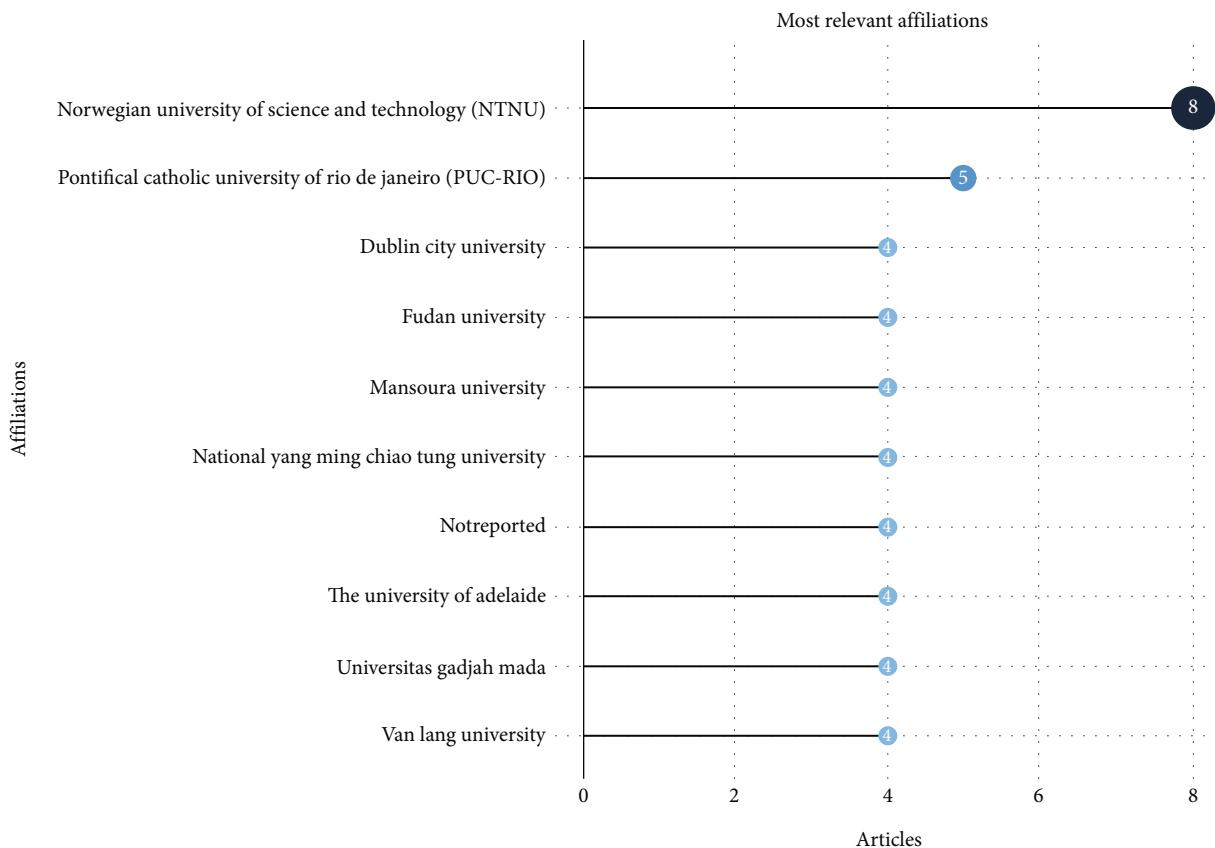


FIGURE 9: Top 10 most relevant academic institutions in the open banking knowledge space.

propose an integrated approach supporting the implementation of central bank digital currencies (CBDCs) compliant with European PSD2 requirements, enriching CBDC wallets with electronic identification capabilities for enhanced functionality and regulatory compliance.

**4.2.2. Contextual Studies Based on Adopted OBApp.** The contextual analysis of OB research delineates four primary categories based on the nature of embraced initiatives, encompassing regulatory PSD2 initiatives studies, other regulatory non-PSD2 initiatives studies, market-driven initiatives studies, and mixed-initiatives studies.

**4.2.2.1. Regulatory PSD2 Initiative Studies.** In the domain of PSD2 implementation, Savoie et al. [70] scrutinize recent developments in payment services regulation within the United Kingdom and EU, encompassing reforms, crypto-asset regulation, and buy-now-pay-later agreements, elucidating their implications on payment services. Dinckol et al. [71] explore standardization efforts in the UK banking sector vis-a-vis OB regulations, delineating their role, evolution, and impact on industry architecture through an inductive qualitative study. They assert that standardization, as a multistakeholder process, responds dynamically to industry exigencies, influencing shifts in industry architecture. Additionally, Prezioso et al. [72] investigate PSD2's role in enhancing financial inclusion, particularly in the Netherlands' fintech landscape, identifying infrastructure strengthening

while acknowledging persisting challenges. They recommend tailored adjustments in know your customer (KYC) processes and collaborative efforts among microfinance institutions (MFIs), fintechs, and banks to foster inclusive OB sector development. Moreover, Ferretti [73] scrutinizes legal inconsistencies arising from the intersection of PSD2 and the General Data Protection Regulation (GDPR) in the EU, discerning operational risks and advocating for regulatory refinement to mitigate inconsistencies and fortify data protection. Finally, Ferretti and Petkoff [74] analyze EU policy and legislative frameworks pertinent to open finance, questioning their efficacy in empowering consumers and mitigating data-driven risks, advocating for regulatory recalibration.

**4.2.2.2. Other Regulatory Non-PSD2 Initiative Studies.** Exploring the impact of blockchain technology on fund transfer transactions between local banks in Egypt, Hefny et al. [3] report blockchain and OB API architecture leveraging to offer enhanced security, transparency, data integrity, and instant settlement, contributing to digital transformation in Egyptian financial sector. Similarly, Billiam et al. [6] stress the importance of open API standardization in Indonesian OB implementation, advocating for a National Standard for Open API Payment (SNAP) to ensure uniformity and regulatory compliance. In a separate study relying on monthly stock data of all banks listed on the Indonesian Stock Exchange, Sapulette et al. [75] analyze fintechs' impact on larger banks during the COVID-19 pandemic in Indonesia,

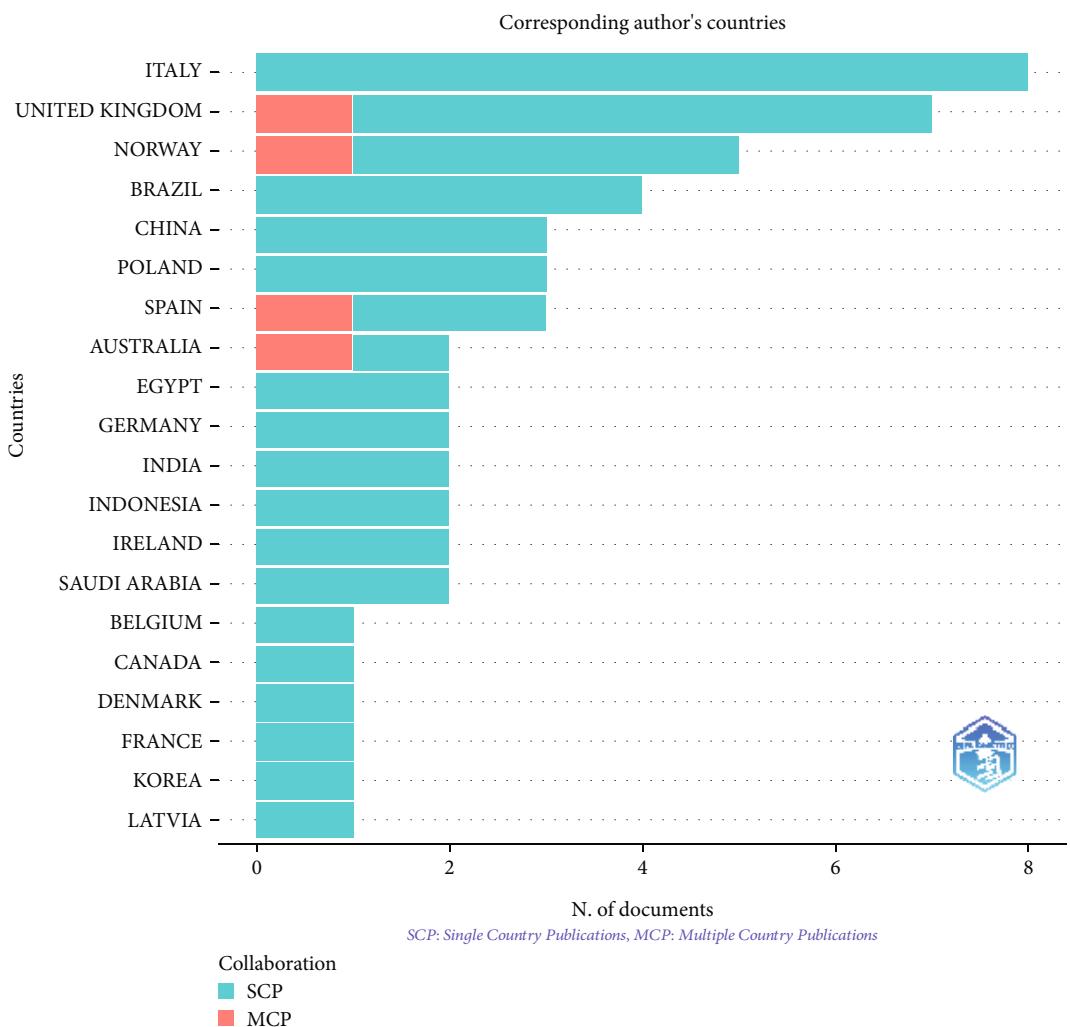


FIGURE 10: Top 20 most relevant corresponding author's countries in the open banking knowledge space.

highlighting relatively diminished adverse effects and discussing implications for OB strategies and financial regulations.

Additionally, Gonçalves and de Araujo [37] offer insights into OB implementation in Brazil, recognizing regulatory hurdles and industry shifts toward client-centric strategies. Moreover, relying on a qualitative analysis of OBApps globally and a focus on the Turkish experience, Aytaş et al. [26] identify critical parameters for success in national OB initiatives, emphasizing regulatory involvement and infrastructure standardization. Similarly, emphasizing Australia's focus on data protection and consumer empowerment, while discussing the impact of OB on established banks and the emergence of open data capitalism, Dahdal and Zeller [22] provide a global survey of OB regulatory developments, contextualizing Australia's CDR within the broader landscape, highlighting its alignment with data protection principles and its transformative impact on the banking sector.

**4.2.2.3. Market-Driven Initiative Studies.** Exploring the growth of OB in India, focusing on technological advancements and partnerships driving its adoption, exemplifying Indian banks' commitment to embracing OB practices, and

fostering digital transformation, Patki and Sople [27] reveal that Indian banks, including Federal Bank, Yes Bank, ICICI Bank, and RBL Bank, have made significant strides in the OB ecosystem, with significant investments in technology and changes in organizational culture demonstrating a commitment to meeting new challenges.

**4.2.2.4. Mixed-Initiatives Studies.** Utilizing bank-level and individual-level data, Fang and Zhu [76] examine OB's influence on traditional bank loans in BRICS nations (Brazil, Russia, India, China, South Africa), highlighting its role in promoting financial inclusion. Indeed, the study found that OB significantly diminishes consumer loan lending and consumer's propensity to acquire loans from traditional banks, indicating a noteworthy influence on both supply and demand sides of individual loans from traditional banks. Additionally, exploring challenges in OB, focusing on regulations like PSD2 and GDPR, while comparing the impact of regulatory regimes on OB progress in the EU and Australia, Zeller and Lynch [36] underscore the imperative of regulatory action and consumer acceptance for OB's success.

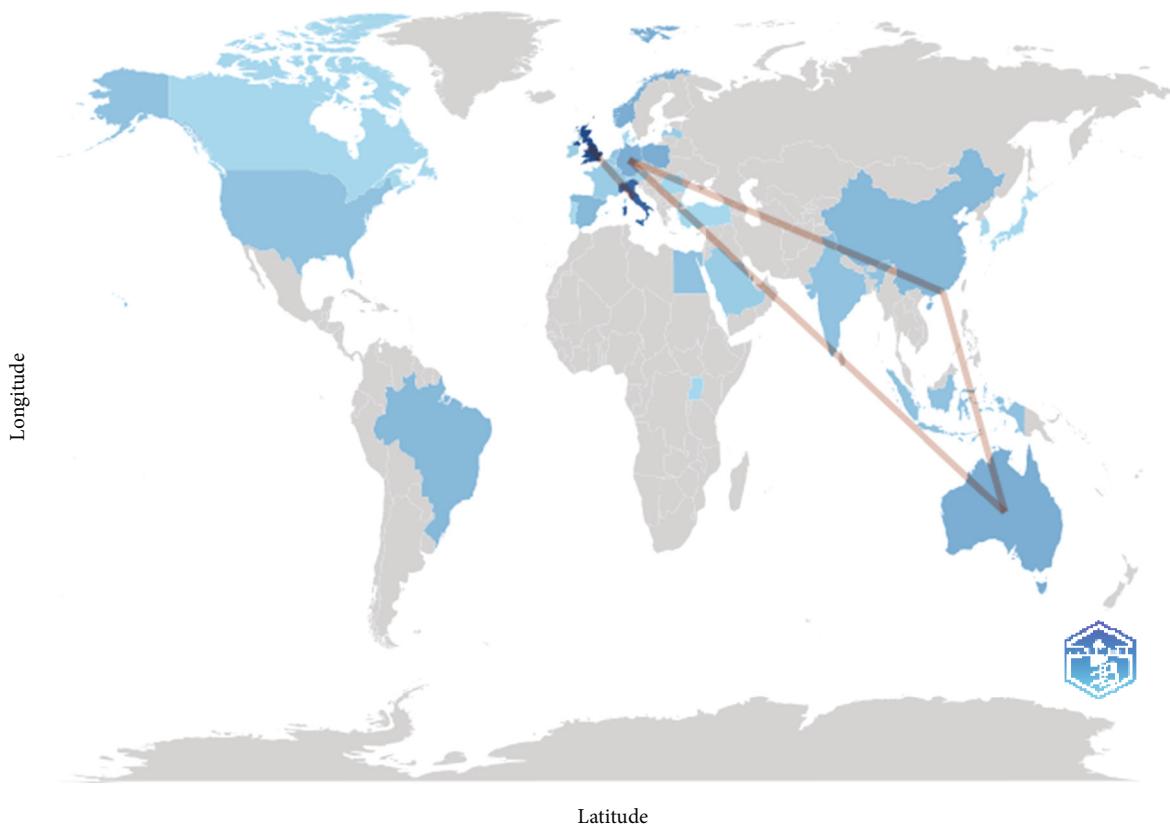


FIGURE 11: Country collaboration world map. Note: this graph/map characterizes the international social structure of the OB knowledge space.

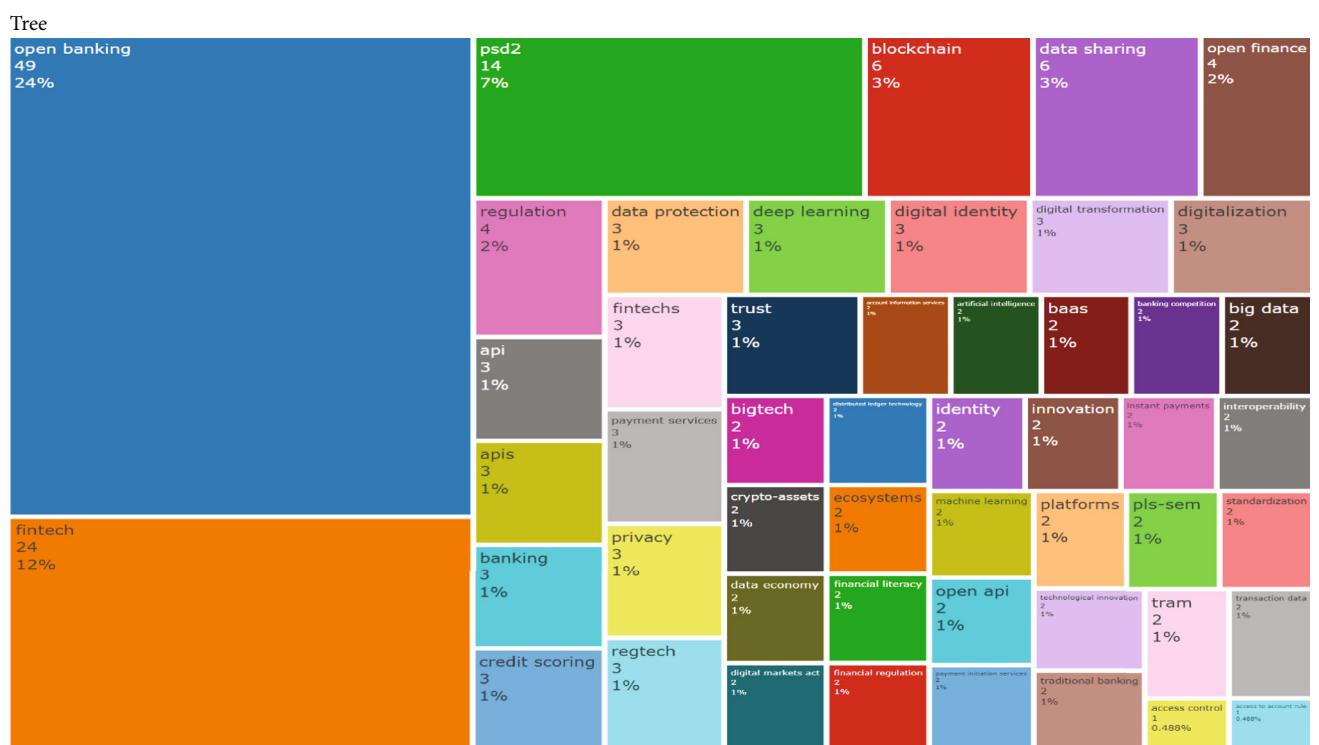


FIGURE 12: Tree map plot of the most relevant words in the open banking knowledge space.

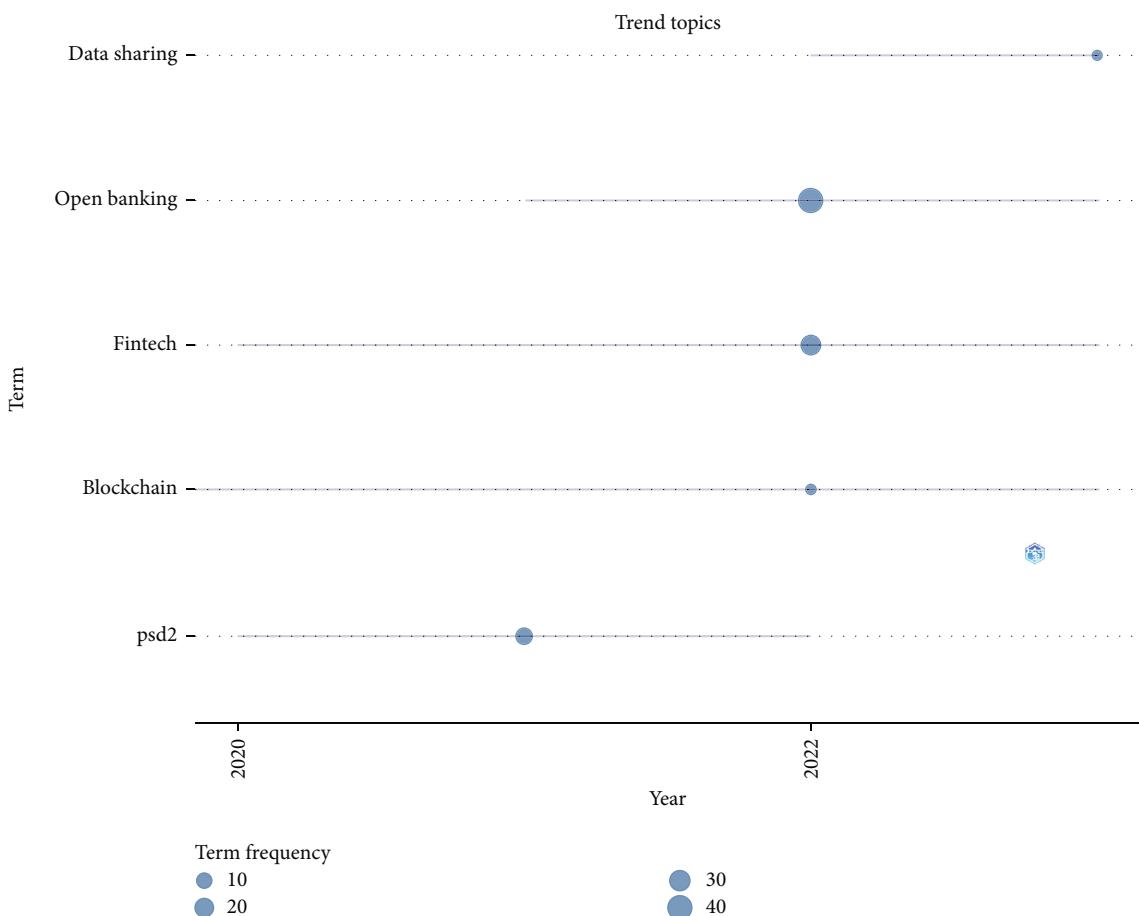


FIGURE 13: Trends of the topics in the open banking knowledge space.

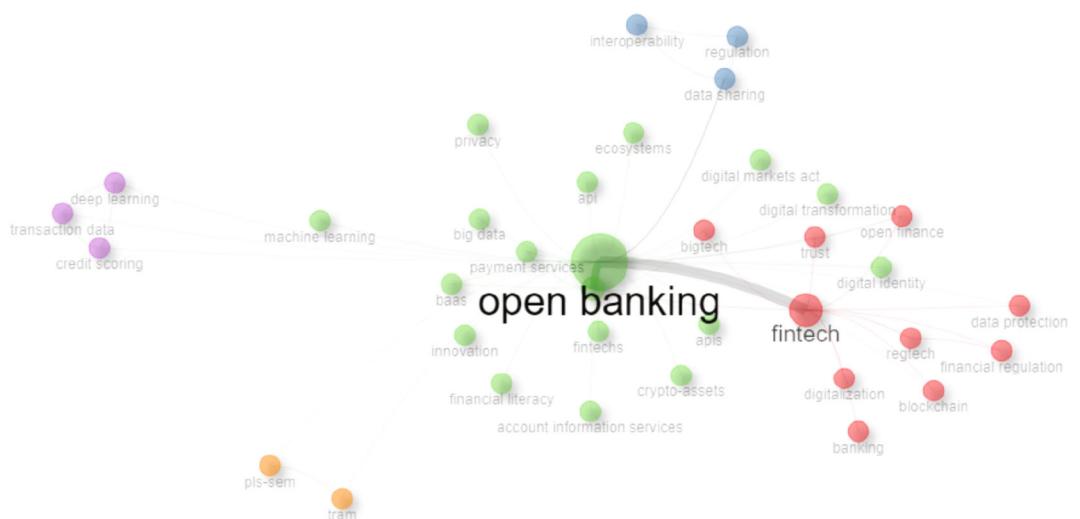


FIGURE 14: The coword network map of the open banking knowledge space.

**4.2.3. OB Consequences for Market Participants.** In addition to the aforementioned literature classification, scholars have delved into the ramifications of OB for the financial services market, traditional banks, and consumers. This subsection provides an overview of this literature.

**4.2.3.1. OB and Financial Service Market Outcome.** Considering the regulatory goal of promoting competition and taking into account credit quality inference and borrower preferences, He et al. [77] highlight the potential of OB to either bolster or impede competition contingent upon its

impact on borrower screening. In a similar vein, exploring how the evolving fintech landscape driven by new technologies and regulatory shifts, including PSD2, is impacting the banking industry, Omarini [8] prompted banks to re-evaluate their value chains and embrace OB models for resilience.

At the individual country level, using the UK OB experience as an example, Borgogno and Colangelo [78] scrutinized how technological innovations, notably the access-to-account (XS2A) rule in PSD2, influence competition in the retail financial sector, stressing the importance of standardized APIs for interoperability and innovation. Likewise, aiming to explore how antitrust enforcement relates to regulatory efforts in the UK OB market, Borgogno and Manganelli [9] examined the procompetitive effects of the XS2A rule in the UK's fintech regulatory framework, underlining its role in nurturing competition. Also focusing on the UK OB experience, Colangelo and Borgogno [79] proposed an interoperability model for IoT ecosystems in the UK OB landscape to ensure market contestability and innovation incentives.

On the other hand, Popova and Cernisevs [80] explored the costs and benefits of shared financial services in Rome, revealing the profitability threshold for fintech companies operating in OB-related services. In a similar vein, Nguyen [81] revealed seven critical success factors for the sustainability of Vietnamese fintech businesses including customer centricity, low profit margin, agility, scalability, security management, innovation, and compliance ease. Additionally, Fratini Passi [82] assessed Italy's OB landscape, highlighting collaborative initiatives beyond traditional banking as indicative of a shift toward open finance. Moreover, Babin and Smith [16] recommended a balanced approach to OB implementation, prioritizing consumer security and protection, while emphasizing the importance of a consistent framework for a successful and value-driven OB model.

Adopting also a multicase study approach to explore open data strategy development in retail banking, Grassi et al. [83] highlighted three approaches to OB and their relationship with corporate cultures, organizational configurations, technological architecture, which maximize customer value through data-driven product design and price customization. Furthermore, Grabowski [84] examined the legal validity and challenges of virtual account models, focusing on mass payment accounts and virtual IBAN (vIBAN) from the perspective of Polish law, to emphasize the justification for vIBAN services under EU law while addressing compliance and enforcement issues.

**4.2.3.2. OB and Traditional Bank Welfare.** Examining the evolution of the banking sector in response to digitalization and OB from a supply-side perspective, Stefanelli and Manta [11] qualitatively analyzed European banks' partnerships and API adoption from 2015 to 2022. Their findings offer policy implications for regulators, highlighting the need for banks to manage risks associated with outsourcing and integrate services effectively. Additionally, reviewing the impact of PSD2 on fast payment systems in Europe through case studies of banking-as-a-service platform Solarisbank and Islamic digital bank Insha in Germany, Nanaeva et al. [33]

underscored the significant enhancements in payment speed resulting from OB and PSD2 regulation. Moreover, exploring Industry 4.0 transformations in the Brazilian banking sector, Quattrochi et al. [1] conducted a neo-Schumpeterian analysis to evaluate established banks' competitive strategies amidst emerging technological trends. They emphasized the importance of regulatory advancements for fintechs in maintaining financial strength and liquidity, advocating for enhancements in the national regulatory framework.

**4.2.3.3. OB Adoption by Consumers.** Turning to the demand side, Szopiński [85] investigated the relationship between consumer awareness and switching behavior in the banking sector, particularly regarding OB. Their primary data analysis revealed that clients in the switching group exhibited higher awareness levels, suggesting more conscious decision-making.

Several studies delved into the impact of OB on consumers' welfare within PSD2-regulated environments. For instance, Briones de Araluz [86] identified underperforming OB models in Europe and proposed a roadmap to address identified weaknesses, emphasizing the importance of customer understanding, usefulness, and trust in driving adoption. Similarly, Rosati et al. [87] conducted a preliminary study across six European countries to identify the determinants of consumers' acceptance of account information services (AISs) under PSD2, highlighting the role of various perceptions in shaping adoption intentions. At the single EU country level, Briones de Araluz and Cassinello Plaza [88] assessed the impact of select factors on the behavioral intention to adopt OB services in Spain, emphasizing perceived usefulness, social influence, and initial trust as crucial determinants. In France, Assala et al. [89] explored the perceptions of digital natives regarding OB, revealing its impact on trust levels in banks.

Several studies also report on the impact of OB on consumer's welfare within other regulatory environments. For instance, Chan et al. [90] extended the Unified Theory of Acceptance and Use of Technology (UTAUT) to investigate Australian consumers' OB adoption, highlighting the role of perceived risk, initial trust, and financial literacy in adoption. Additionally, Alsmadi et al. [91] revealed the legal environment, together with consumers' gambling attitudes, perceived benefits, and market uncertainty to significantly determine the behavioral intention to continue using cryptocurrencies in the UAE. Moreover, Mutambik [92] proposed a model for understanding customer experience and loyalty toward OB brands and apps in Saudi Arabia, identifying key drivers such as ease of use and perceived value. Similarly, Johri and Kumar [93] reported a positive impact of banking digital transformation in Saudi Arabia, with awareness of cyberattack, phishing, and hacking activities reportedly influencing customer satisfaction with digital financial transactions.

On the other hand, employing quantitative and qualitative approaches, including structural modeling to explore consumer readiness for OB in eight major cities in Indonesia, Iman et al. [94] emphasized critical factors such as organizational support and user-friendly technology. Similarly,

using survey data collected from 378 Malaysian Alipay users, Tian et al. [95] found support for all hypotheses regarding emerging markets consumers' intention to use the Alipay e-wallet system, as an OB service. In addition to relative efficiency and convenience for conducting financial activities, perceived usefulness was identified as the strongest predictor factor, followed by perceived ease of use. Furthermore, investigating customers' readiness to adopt API-based metaverse banking services in Vietnam, using the Unified Theory of Acceptance and Use of Metaverse Technology (UTAUMT) model, Nguyen et al. [96] revealed strong support for model constructs such as metaverse performance expectancy, metaverse facilitating conditions, metaverse effort expectancy, and metaverse social influence, along with metaverse trust and metaverse financial resources.

Finally, within the context of a market-driven environment, focusing on India, Sivathanu [97] utilized the Technology Readiness and Acceptance Model (TRAM) to assess customers' intention to use OB technology, uncovering factors such as optimism and innovativeness affecting perceived ease of use and usefulness. In a similarly vein, utilizing the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model to examine the relationship between the independent variables (i.e., performance expectancy, effort expectancy, social influence, facilitating conditions, and hedonic motivation) and the dependent variables (i.e., behavioral intention to use mobile payment apps and use behavior), Linge et al. [98] found support for all six proposed hypotheses, with the proposed model explaining a substantial amount of variance in behavioral intention and use behavior among experienced mobile payment app users, in the Vidarbha region of India.

While the existing literature extensively addresses various facets of OB, including its impact on security and consumer adoption, it falls short in adequately addressing the financial consequences of its adoption for consumers on a global scale. This gap is the focus of the current analysis.

**4.3. Descriptive Statistics and Spatial Trends in the Distribution of the Outcome Variables.** The descriptive analysis of the study sample, derived from the second update of the 2021–2022 World Bank's Global Findex surveys, yielded findings summarized in Table A4. As depicted in the table, the survey comprised 143,887 respondents from 139 nations. The majority of respondents, constituting 52.57% (or 75,636 individuals), reported residing in countries without OB initiatives. This was followed by 18.46% (or 26,565 individuals) residing in countries regulated under the PSD2. Additionally, 16.78% (or 24,138 individuals) reported residing in other non-PSD2-regulated countries, while 12.20% (or 17,548 individuals) reported living in countries with market-driven OB initiatives. Figure 15 summarizes the global cross-country variations in OBApps.

However, regarding urban residency status, only 22.09% (or 31,781 individuals) of respondents reported living in urban areas. Table A4 further indicates that 28.35% (or 40,786 individuals) of respondents formally saved money in the 12 months prior to the survey, while 33.65% (or 48,413 individuals) reported using a mobile phone or the internet to send money to a friend or relative during the

same period. Figure 16 illustrates the cross-country heterogeneity in formal saving behaviors, while Figure 17 highlights the cross-country variability in digital remittance behaviors among respondents in the study sample.

Regarding the status of financial inclusion, Table A4 illustrates that 65.6% (or 94,390) of respondents indicate having a bank account with a formal financial institution, while 14.96% (or 21,525) report having a mobile money account. Furthermore, ownership of debit cards is reported by 50.70% (or 72,945) of respondents, whereas credit card ownership is reported by only 22.68% (or 32,634) of respondents. Additionally, Table A4 indicates that a majority of respondents (37.86% or 54,471) report experiencing significant difficulty accessing emergency funds, followed by 33.06% (or 47,571) reporting no difficulty at all and 29.08% (or 41,845) reporting a somewhat challenging experience. Concerning financial transfers receipts, Table A4 demonstrates that 38.24% (or 55,016) of respondents report receiving wage payments over the previous 12 months, while 19.26% (or 27,707) report receiving some form of governmental support during the same period.

Regarding demographic and socioeconomic characteristics, Table A4 reveals that 53.23% (or 76,585) of respondents identify as female, with an average age of 41.05 years and a standard deviation of 17.32 years. Moreover, the majority of respondents report having a secondary level of education (50.32% or 72,401), followed by 27.34% (or 39,343) reporting at most a primary level and 22.34% (or 32,143) reporting at least a tertiary level. Additionally, most respondents report being active in the labor force (64.4% or 92,659), with only 35.6% (or 51,228) reporting inactivity. Furthermore, the income distribution within the sample reveals that the majority of respondents belong to the highest income quintile (25.84% or 37,182), followed by 21.49% (or 30,926) in the fourth income quintile, 19.14% (or 27,546) in the middle income quintile, 17.29% (or 24,880) in the second income quintile, and 16.23% (or 23,353) in the lowest income quintile. Lastly, Table A4 also indicates that the majority of respondents, 88.05% (or 126,695), report owning a mobile phone, with 70.17% (or 100,970) having access to the internet and 57.66% (or 82,959) engaging in utility bill settlement over the previous 12 months.

**4.4. Econometric Modeling Results.** The outcomes of the spatial semiparametric bivariate probit model estimation concerning individual consumers' formal saving and digital remittance behaviors in the era of OB are encapsulated in the rightmost section of Table A8. The subsequent subsections delineate these findings.

**4.4.1. OBApp Impact on Individual Consumers' Financial Behaviors.** The examination of the effects of national OB initiatives elucidates an overall positive influence on the MUs derived by individual consumers from formal saving and digital remittance. As evident from Table A8, compared to consumers residing in countries devoid of OB initiatives (NA), those inhabiting nations with market-driven initiatives (MD) exhibit a 37% higher MU from formal saving, while individuals in PSD-regulated countries (RP) demonstrate a

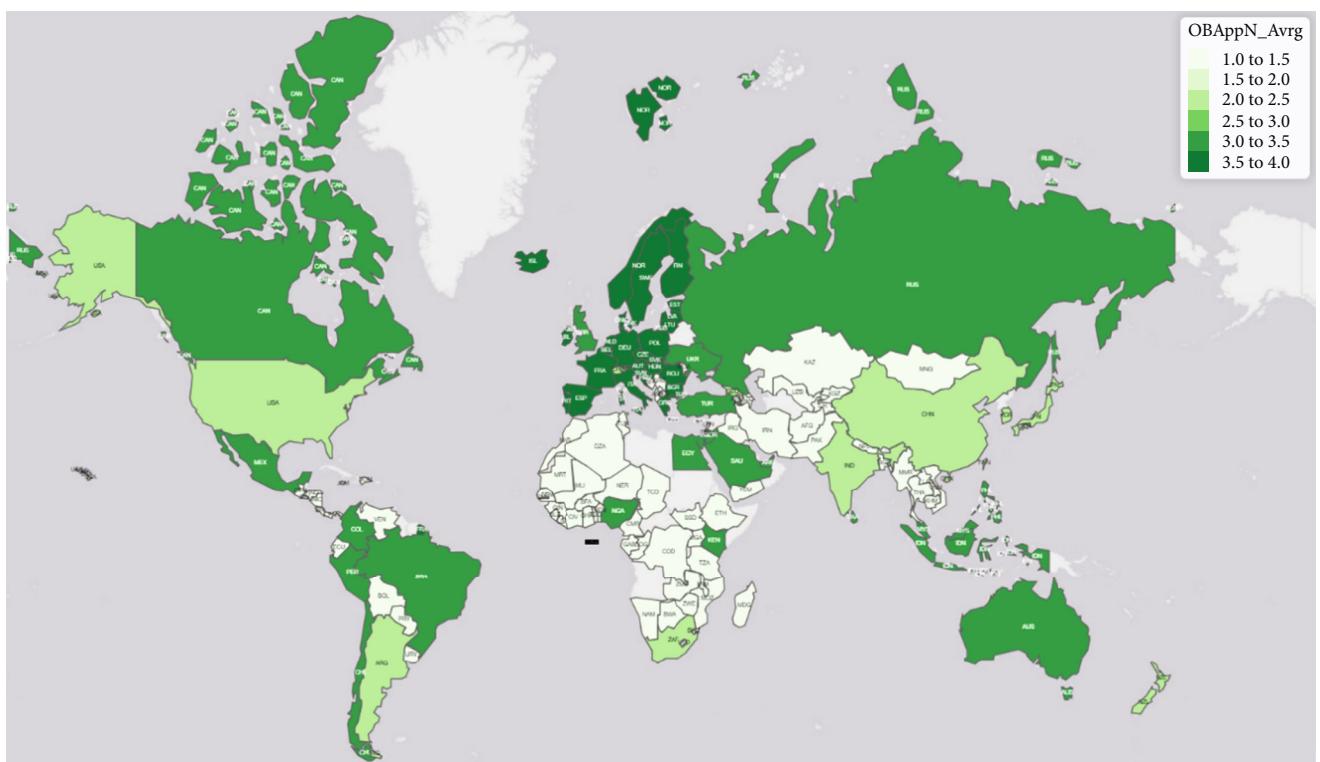
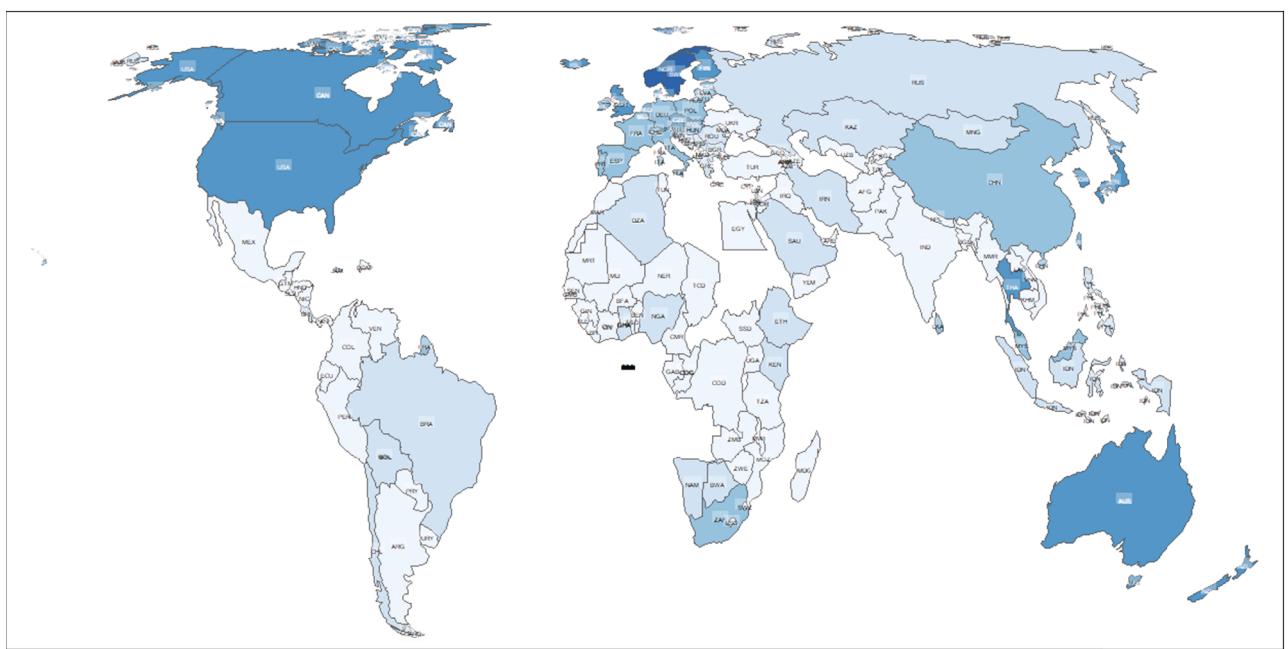


FIGURE 15: Cross-country variations in open banking approach (1: no OB initiative “NA”; 2: market-driven OB initiatives “MD”; 3: other non-PSD2-regulated OB initiatives “RO”; 4: PSD2-regulated initiatives “RP”). Source: authors’ own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.



pSavBkAccFinInst12M

0 to 20	60 to 80
20 to 40	80 to 100
40 to 60	

FIGURE 16: Spatial distribution of national level weighted percent frequency of individuals with reported formal saving during the 12 months prior, in the era of open banking. Source: authors’ own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

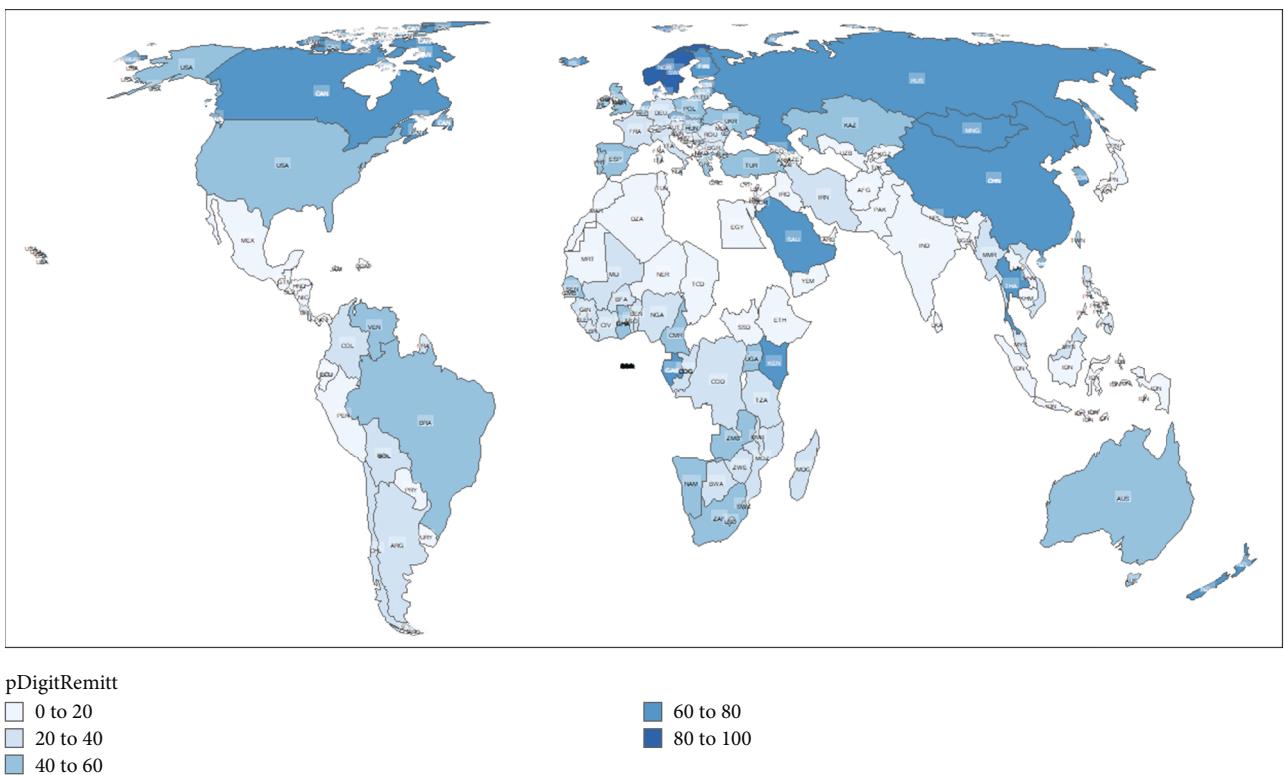


FIGURE 17: Spatial distribution of national level weighted percent frequency of individuals reporting having sent money using digital channels (i.e., digital remittance) in the era of open banking. *Source:* authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

relatively 61.8% higher MU from formal saving. Conversely, consumers from other non-PSD2-regulated countries show no significant MU deviation from formal saving compared to their NA counterparts. Similarly, the final column of Table A8 illustrates that in contrast to consumers in NA countries, those in MD nations, as well as those in other non-PSD2-regulated (RO) and PSD2-regulated economies, manifest, respectively, 52.6%, 39.1%, and 56.7% higher MUs from digitally remitting money.

These findings suggest a greater likelihood of formal saving among consumers in both market-driven and PSD2-regulated countries compared to their counterparts in nations lacking OB initiatives. Moreover, they indicate that irrespective of the chosen implementation approach, the adoption of OB significantly boosts consumers' digital remittance behaviors, with RP demonstrating the highest behavioral impact at 56.7%, followed by MD at 52.6%, and finally RO at 39.1%.

**4.4.2. Financial Inclusion Impact on Individual Consumer's Financial Behaviors.** As delineated in the conceptual framework illustrated in Figure 3, financial inclusion is comprehensively defined utilizing seven distinct demand-side indicators. The estimated effects of these indicators are depicted in the upper section of Table A8, under the column labeled "spatial semiparametric specification."

Commencing with the first indicator, Table A8 illustrates that individuals with documented access to a formal

bank account consistently exhibit higher probabilities of engaging in formal saving and digital remittance to family and friends in the OB era. Indeed, in comparison to their unbanked counterparts, those with access to a formal bank account demonstrate 1.021 times higher MU from formal saving and 29.7% higher MU from digital money transfer.

Similarly, individuals with documented access to a mobile money account display significantly higher probabilities of formal saving and digital remittance in the OB era. In contrast to individuals without a mobile money account, those with ownership report 26.7% higher MU from formal saving and 1.022 times higher MU from digital money transfer. Moreover, individual holders of debit cards and credit cards also exhibit consistently higher probabilities of formal saving and digital remittance. Table A8 demonstrates that compared to their counterparts without debit cards, individuals with ATM debit cards report 22.9% and 35% higher MUs from formal saving and digital remittance, respectively. Likewise, individuals reporting credit card ownership, compared to those without, exhibit 21.5% and 26.9% higher MUs from formal saving and digital remittance, respectively.

Regarding access to emergency funds, Table A8 indicates that individuals perceiving easier access to emergency funds in the OB era have higher probabilities of engaging in formal saving and digital remittance. In contrast to those reporting extreme difficulty accessing emergency funds, individuals reporting a somewhat difficult experience and those reporting no difficulty at all exhibit 32% and 63.2% higher MUs

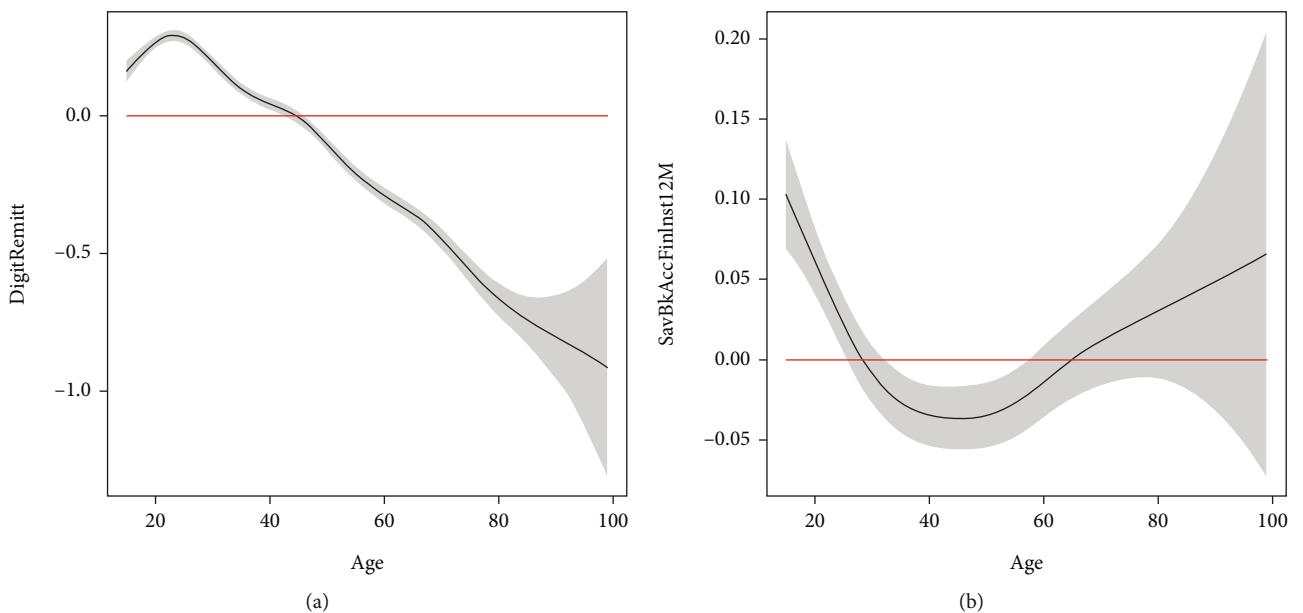


FIGURE 18: Smooth function plots of the nonlinear impacts of age on the representative consumer's derived marginal utilities from formally saving money with a financial institution (b) and also sending some through digital channels to a friend or family member "digital remittance" (a) in the era of open banking.

from formal saving, along with 15.8% and 23.1% higher MUs from digital remittance, respectively. Additionally, Table A8 unveils that individuals reporting receipt of wage payments and government transfers over the previous 12 months consistently display higher probabilities of formal saving and digital remittance in the OB era. Compared to their counterparts without wage reports, those reporting wage transfer receipts demonstrate 18.4% and 17.6% higher MUs from formal saving and digital remittance, respectively. Similarly, relative to individuals without public transfers, those reporting government transfer receipts exhibit 4.6% and 10.6% higher MUs from formal saving and digital remittance, respectively.

In summary, based on the findings from all seven demand-side financial inclusion indicators, it can be inferred that formal financial inclusion has a significantly positive impact on formal saving and digital remittance behaviors in the OB era on a global scale. These empirical findings lend support to the "financial inclusion hypothesis" advocated by proponents of OB initiatives worldwide.

**4.4.3. Sociodemographic Factors' Impact on Individual Consumer's Financial Behaviors.** The conceptual framework outlined in Figure 3 underscores three sociodemographic control variables (i.e., gender, age, and education level) with potential sway over individuals' formal saving and digital remittance behaviors. The summarized findings in Table A8 unveil a noteworthy gender-based gradient favoring males in both formal saving and digital remittance behaviors during the OB era. In comparison to their male counterparts, females exhibit 2.1% and 2.7% lower MUs, thereby indicating diminished probabilities of engaging in formal saving and digitally remitting money to family and friends.

Concerning education, Table A8 accentuates significantly positive and escalating impacts of higher educational attainment levels on the probabilities of formal saving and digital remittance in the OB era. Relative to individuals reporting at most a primary level of education, those with a secondary education and those with at least a tertiary education level demonstrate 8.5% and 27.6% higher MUs from formal saving, along with 13.2% and 37.6% higher MUs from digitally remitting money to family and friends, respectively.

Furthermore, the lower segment of Table A8 delineates the influence of age. It is discernible that the estimated density functions (edfs) of the effects of age on individuals' derived MUs from formal saving (edf = 131.8) and digitally remitting (edf = 134.273) are both statistically significant, evident from their respective  $p$  values falling well below the 5% alpha level. As illustrated in the smooth function plots in Figure 18, this age-related impact is nonlinear for both formal saving (right quadrant) and digital remittance (left quadrant). While the impact on formal saving behavior assumes a convex shape (i.e., positive and decreasing up to approximately 26 years of age and then negative and decreasing up to around 41 years of age before starting to ascend thereafter), the impact on digital remittance takes on a concave form (i.e., positive and increasing up to around 23 years of age, followed by a decline thereafter, reaching a negative impact beyond 40 years and beyond).

**4.4.4. Personal Economic Factors' Impact on Individual Consumers' Financial Behaviors.** The conceptual framework depicted in Figure 3 also underscores five individual-level economic control variables with potential sway over formal saving and digital remittance behaviors. The results presented in Table A8 elucidate that participation in the global

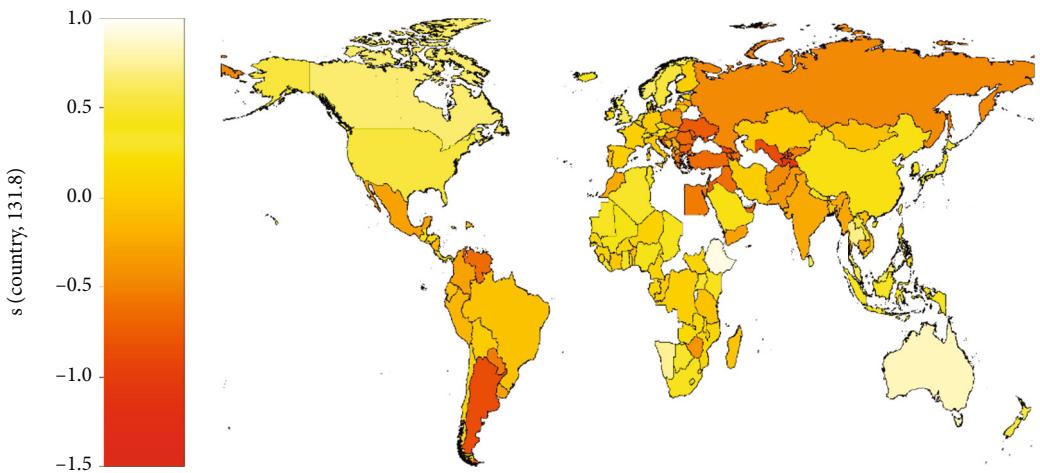


FIGURE 19: Post-estimation conditional spatial heterogeneity in the representative consumer's marginal utility from formally saving with a financial institution, in the era of open banking.

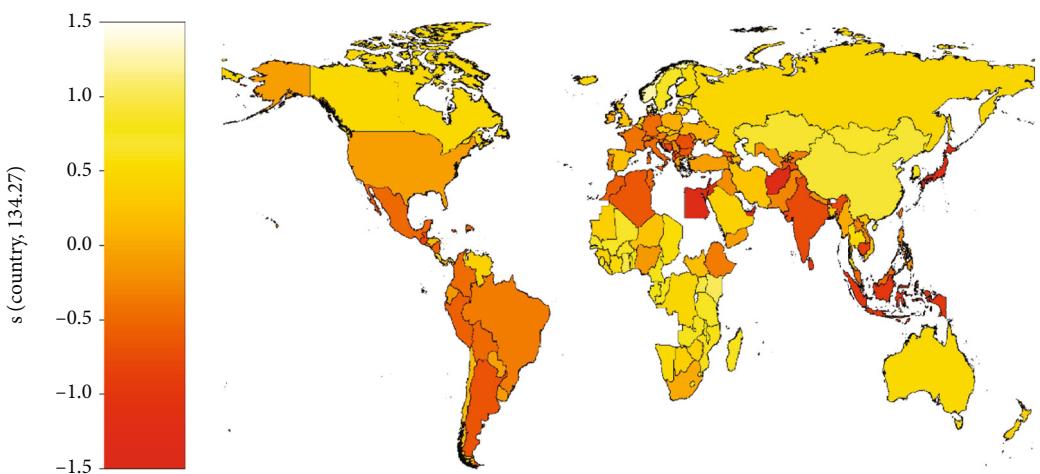


FIGURE 20: Post-estimation conditional spatial heterogeneity in the representative consumer's marginal utility from sending money through digital channels, in the era of open banking.

labor market consistently correlates with heightened probabilities of engaging in formal saving and digital remittance practices during the OB era. In comparison to their inactive counterparts, individuals reporting involvement in the global labor force exhibit 10.8% and 9.6% higher MUs from formal saving and digitally remitting money to family and friends, respectively.

Furthermore, Table A8 illustrates that ascending individual income levels in the OB era positively contribute to increased probabilities of formal saving and digital remittance to family and friends. In contrast to those situated in the lowest income quintile, individuals in the second, third, fourth, and fifth income quintiles consistently demonstrate higher MUs from formal saving at rates of 8.3%, 14.4%, 19.2%, and 29%, respectively, along with elevated MUs from digital remittance at rates of 7.2%, 12.3%, 17.2%, and 26.2%, respectively.

Moreover, Table A8 unveils that globally individuals reporting ownership of mobile phones are significantly

more inclined to partake in formal saving and digital remittance behaviors in the OB era. In comparison to individuals without mobile phones, those with mobile phone ownership exhibit 5.5% and 37.3% higher MUs from formal saving and digitally remitting money to family and friends, respectively.

Likewise, individuals with reported access to the internet are notably more inclined to engage in formal saving and digital remittance behaviors during the OB era. Relative to those without internet access, individuals with internet access demonstrate 11.9% and 36.1% higher MUs from formal saving and digitally remitting money to family and friends, respectively. Additionally, in contrast to their counterparts reporting no utility bills payment, individuals with reported bills payments over the previous months exhibit 12.8% and 11.9% higher MUs from formal saving and digital remittance to family and friends, respectively.

**4.4.5. Geospatial Factors' Impact on Individual Consumers' Financial Behaviors.** The influence of geospatial factors, namely, urban residency status and country of residence, is delineated in Table A8. It is evident that urban residency significantly augments the propensity for formal saving but diminishes the likelihood of digitally remitting money to family and friends during the OB era. Relative to their rural counterparts, individuals reporting urban residency manifest a 4.6% higher MU from formal saving, along with a 6.6% lower MU from digitally remitting money to family and friends.

Furthermore, the random country effects, depicted subsequent to the estimation of the geospatial econometric model, underscore substantial cross-country heterogeneity in individual formal saving and digital remittance behaviors in the OB era. Illustrated in Figure 19 for formal saving behaviors and Figure 20 for digital remittance behaviors, this cross-country heterogeneity in individuals' financial inclinations accentuates the impacts of various national-level factors that exert explanatory influences on the utility derived from formal saving and digital remittance to family and friends. Notably, these factors encompass sociocultural, macroeconomic, and regulatory dimensions, as well as differences in OB infrastructural readiness among countries, among others, which have not been explicitly accounted for in the current analysis.

## 5. Discussion and Conclusions

**5.1. Interpretation and Discussion of the Results.** As an evolving phenomenon in the financial sector, OB has garnered global acceptance since its inception in the United Kingdom in 2018 [25]. While existing literature extensively covers critical aspects of OB, such as its security implications and drivers for consumer adoption, there remains a notable gap in studies addressing its financial ramifications for consumers, particularly on a global scale. To our knowledge, only Kellezi et al. [60] have reported improved savings behaviors and positive habits among users through an innovative web solution using model-view-controller architecture to tackle security challenges arising from OB, post the implementation of PSD2 regulation. Thus, through a retrospective-prospective mixed methods design, combining bibliometric analysis with geospatial econometric modeling, this study not only elucidates ongoing trends in OB literature but also delineates consumers' substantial demand for and access to digital financial services (formal saving and digital remittance) in the OB era. Additionally, it evaluates the varying effectiveness of different OB initiatives adopted worldwide. The key conclusions drawn from our findings are as follows:

- i. The OB knowledge domain is characterized by diverse source coverage, encompassing business, law, information systems, computer science, and multidisciplinary fields, with seven core academic journals representing primary sources of OB knowledge. Notably, the Norwegian University of Science and Technology emerges as a significant academic institution, with Borgogno

being the most prolific author in the OB knowledge domain. Moreover, Italy emerges as the leading contributor country, although collaborations across countries, particularly between Australia and select European nations (e.g., United Kingdom, Spain, and Norway), appear limited.

- ii. Regarding consumers' extensive demand for and access to formal banking and digital remittance in the OB era, our results reveal that 28.35% of participants report formal savings at financial institutions, while 33.65% report digital money transfers to family and friends. Inferentially, these figures suggest a global savings rate of 28.35% and a remittance rate of 33.65% during the early stages of OB implementation worldwide. However, given that 52.57% of respondents reside in countries without OB initiatives, while 12.2% live in countries with market-driven initiatives, 18.46% in PSD2-regulated countries, and the remaining 16.78% in other non-PSD2-regulated countries, significant potential exists for enhancing global rates of formal saving and digital remittance, especially as more countries, notably in Africa, embark on the OB journey.
- iii. Consistent with the aforementioned observations, consumers in both market-driven and PSD2-regulated countries exhibit relatively higher likelihoods of savings compared to their counterparts in countries without OB initiatives. Furthermore, irrespective of the chosen implementation approach, OB initiatives demonstrate a significantly positive impact on consumers' digital remittance behaviors, with PSD2 initiatives eliciting the most substantial behavioral responses at 56.7%, followed by market-driven initiatives at 52.6% and other regulatory non-PSD2 initiatives at 39.1%.

Overall, the bibliometric findings support the significance of our study, which brings together authors from four academic institutions spanning three countries (UAE, Canada, and Bangladesh) and three world regions (Middle East, North America, and Asia), thereby expanding the existing social, conceptual, and intellectual structures within the OB knowledge domain. These bibliometric findings complement previous reports from studies employing broader perspectives to review OB literature, offering insights into research trends, themes, and potential future directions. For instance, Gupta et al. [4] employed scientometric techniques to analyze 415 documents in the OB research field, while De Pascalis [99] examined the OB experience across jurisdictions, exploring the development of an open financial data ecosystem.

Additionally, the financial services demand-side effects of OB in (ii) and (iii), as demonstrated through geospatial econometric modeling, based on random utility theory, uniquely complement the supply-side effects described in existing literature. For example, Hjelkrem and Lange [100] emphasized model interpretability and predictive performance using OB data, while Paneque et al. [101] developed ontology-based semantic models for OB operations, facilitating data integration and sophisticated analysis. Furthermore, Svetlošák et al. [102] proposed statistical methods for

modeling customer dynamics in OB-type data, enabling personalized service recommendations by financial institutions.

### *5.2. Implications of the Results*

**5.2.1. Implications for Theory Development.** The findings of this study carry significant implications for theory development across finance, economics, and behavioral science disciplines. Specifically, the study sheds light on the impact of OB initiatives on consumer behaviors, offering avenues for future theoretical exploration. Behavioral economics models can incorporate OB as a pivotal factor influencing individuals' financial decision-making processes, delving into the psychological mechanisms underpinning the perceived advantages of OB on formal saving and digital remittance. Furthermore, the study underscores the positive correlation between financial inclusion and formal saving and digital remittance behaviors, suggesting the expansion of theoretical frameworks in financial inclusion to encompass dimensions highlighted in the study, such as access to formal bank accounts, mobile money, and digital infrastructure.

**5.2.2. Implications for Open Innovation in the Financial Services Sector.** The research findings also carry significant implications for the development of open innovation business models, particularly within the financial and banking sectors. By integrating insights from consumer behaviors, financial inclusion, and demographic factors, businesses can formulate more effective and inclusive open innovation strategies aligned with the evolving landscape of OB. For instance, the observed positive impact of OB initiatives on formal saving and digital remittance underscores the importance for businesses to consider incorporating OB platforms into their operations. Firms can innovate business models facilitating collaboration and data sharing among financial institutions, fintech firms, and other stakeholders to enhance the overall financial experience for consumers.

Additionally, given the favorable influence of market-driven initiatives and PSD2 regulation on consumer behaviors, businesses can strategically engage with fintech companies to foster partnerships leveraging the strengths of both traditional financial institutions and innovative startups. This collaborative approach can lead to the development of improved financial services and products. Moreover, the study emphasizes the significance of financial inclusion within the realm of OB, prompting businesses to prioritize inclusive strategies aimed at integrating unbanked populations into the formal financial system. Collaboration with organizations focusing on financial literacy and inclusion can be pivotal in this regard.

Furthermore, the study underscores the importance of mobile phone ownership and internet access in shaping financial behaviors, suggesting investments in open innovation models aimed at enhancing digital infrastructure. This may entail partnerships with telecommunication firms and technology providers to ensure widespread access to digital channels. Moreover, the gender-based gradient in formal saving and digital remittance highlights the importance of user-centric design principles in open innovation business models, urging firms to tailor their initiatives to cater to diverse demographic groups.

Similarly, the nonlinear impact of age on financial behaviors suggests the need for customized solutions targeting different age segments. By offering tailored services, firms can enhance user engagement and satisfaction. Additionally, considering the influence of geospatial factors and cross-country variations in financial behavior, open innovation business models should adopt a global perspective, adapting to diverse regulatory, sociocultural, and economic contexts. Collaboration with local partners and understanding regional nuances can facilitate successful implementation. Finally, given the sensitive nature of financial data involved in open innovation, businesses must prioritize robust data security and privacy measures, integrating state-of-the-art cybersecurity protocols and compliance frameworks to build trust among users and stakeholders.

**5.2.3. Implications for the United Nations Sustainable Development Goals (SDGs).** The findings of this research study carry significant implications for the United Nations SDGs, particularly those aimed at poverty reduction, gender equality, quality education, decent work and economic growth, industry innovation and infrastructure, reduced inequalities, and partnerships for the goals.

**5.2.3.1. Implications for SDG 1 (No Poverty).** The observed positive impact of OB and financial inclusion on formal saving suggests avenues for poverty reduction efforts. Governments and organizations can align their strategies with SDG 1 by prioritizing financial inclusion measures, ensuring broader access to formal banking services. Strategies may include creating an enabling environment for OB through clear regulations that encourage collaboration between traditional financial institutions and fintech companies. Additionally, inclusive product development can cater to the needs of underserved individuals through low-cost banking solutions and simplified digital interfaces. Governments can also explore integrating OB technologies into microfinance programs to support small-scale entrepreneurs. Moreover, innovative credit scoring models utilizing alternative data sources could improve access to financial services for individuals with limited credit histories. Regulatory sandboxes can foster fintech innovation while ensuring compliance and consumer protection.

**5.2.3.2. Implications for SDG 4 (Quality Education).** The study suggests a correlation between higher education levels and formal saving and digital remittance behaviors, indicating avenues for contributing to SDG 4. Policymakers can focus on integrating financial literacy education into school curricula at various levels, in addition to developing specialized courses on OB. Collaborations between fintech companies and educational institutions can facilitate the creation of educational materials and platforms. Interactive learning tools can provide practical experience in using OB services, promoting informed financial decision-making.

**5.2.3.3. Implications for SDG 5 (Gender Equality).** The gender-based gradient in financial behaviors underscores the need for interventions promoting gender equality, aligning with SDG 5. OB can facilitate the development of

gender-inclusive financial solutions, ensuring equal access to digital financial services for women. Partnerships between governments, financial institutions, and fintech companies can support women entrepreneurs and promote diversity in the fintech workforce. Legal and regulatory frameworks should address gender-based discrimination in the financial sector, ensuring women's rights are protected within the context of OB.

**5.2.3.4. Implications for SDG 8 (Decent Work and Economic Growth).** The study indicates that labor market participation and rising income levels positively contribute to financial (formal saving and digital remittance) behaviors, suggesting strategies for fostering decent work and economic growth in line with SDG 8. For instance, governments can support fintech innovation and entrepreneurship through supporting regulatory frameworks that nurture the development of fintech startups and job creation. Additionally, implementing training programs that enhance the skills of the workforce, particularly in the areas of fintech, would help individuals acquire the necessary skills to participate in the rapidly evolving financial landscape driven by OB, thereby fostering employability and job creation. Policies should specifically target SMEs and startups in the fintech sector, encouraging collaboration between the public and private sectors to invest in infrastructure and initiatives, which also integrate sustainability considerations, thereby ensuring that economic growth is environmentally and socially responsible, and aligning with broader global goals and contributing to SDG 8.

**5.2.3.5. Implications for SDG 9 (Industry, Innovation, and Infrastructure).** The positive influence of OB on financial behaviors highlights the role of innovation in contributing to SDG 9. Governments can create innovation hubs and provide funding for R&D activities related to OB. Regulatory sandboxes can foster experimentation and accelerate the development of new financial technologies. Open API standards promote innovation and competition, while robust cybersecurity measures ensure data security in the OB ecosystem.

**5.2.3.6. Implications for SDG 10 (Reduced Inequalities).** The study emphasizes the importance of addressing inequalities in financial behaviors based on factors such as education, gender, and economic status. Policies should be designed to reduce these inequalities and ensure that the benefits of financial inclusion and OB are accessible to all, aligning with SDG 10. This could be achieved by designing policies that promote inclusive access to financial services, including OB, for marginalized populations. Regulatory measures can require financial institutions to offer affordable banking services, while tailored products and services could cater to the needs of vulnerable groups. Accessibility standards for digital platforms could also ensure inclusivity, while cultural sensitivity could further extend financial inclusion within the OB framework.

**5.2.3.7. Implications for SDG 17 (Partnerships for the Goals).** The cross-country variations and global considerations in financial behaviors highlight the importance of interna-

tional cooperation. Governments, financial institutions, and organizations can form partnerships to share best practices, promote financial inclusion globally, and work collaboratively toward achieving the SDGs, particularly SDG 17. To this end, multistakeholder platforms can facilitate collaboration and knowledge sharing, while workshops and training sessions disseminate best practices in OB and financial inclusion. Participating in international conferences can foster global dialogue, while cross-border data collaboration could enhance the effectiveness of OB initiatives. Finally, collaboration on global standards could promote interoperability, fostering a globally inclusive OB ecosystem.

**5.3. Limitations and Future Research Suggestions.** This study presented a detailed analysis of the impacts of OB on individual consumers' financial behaviors, focusing on formal saving and digital remittance. The results suggest that OB, when implemented effectively, can positively impact formal saving and digital remittance behaviors. However, attention must be given to addressing disparities based on socio-demographic and economic factors, ensuring that the benefits of OB are accessible to all.

In addition to its numerous (theoretical and practical) implications, the study provides a couple of notable limitations. For instance, its use of Scopus only for sourcing the bibliographic data could be improved in a prospective study by considering other bibliographic data sources, such as the Web of Science. The secondary and self-reported nature of the data used in the spatial econometric analysis also raises potential data limitation and measurement issues. Indeed, compared to revealed preference data, stated financial preference data are often more prone to inaccuracies due to interpretation and response biases. Therefore, using objective indicators of revealed financial preferences and behaviors could enhance the reliability of the data and the validity of the research findings. For instance, as OB becomes progressively globalized, with standardized protocols and practices, observational data collected directly through the standardized API platforms could ensure an objective evaluation of its impact on consumers' financial behaviors. Moreover, given the time-sensitive nature of OB development and the gradual adoption of various initiatives by countries, a prospective study based on data that includes the 2023–2024 fiscal years would not only offer an updated perspective on our current results but also provide insights into the dynamics of OB over time. Furthermore, future studies could also consider alternative financial behaviors, including investment behaviors of not only individuals but also small and medium-sized companies. Finally, while our study uses a partially linear (or semiparametric) representation of the behavioral complexities of financial consumers, a more nuanced understanding of the OB–financial behavior nexus could be prospectively provided by exploring mediating and moderating effects. Together, these prospective directions would contribute to providing a more comprehensive picture of the welfare implications of OB for financial consumers around the world.

## Appendix

TABLE A1: PRISMA stages, Scopus search string, and search results.

PRISMA stages	Scopus search string	Search results
1. Initial search	TITLE-ABS-KEY ("Open Banking") AND PUBYEAR < 2024	198 documents
2. Selection	TITLE-ABS-KEY ("Open Banking") AND PUBYEAR > 2015 AND PUBYEAR < 2024	194 documents
Subject area restrictions	TITLE-ABS-KEY ("Open Banking") AND PUBYEAR > 2015 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "ENGI"))	186 documents
Document type restrictions	TITLE-ABS-KEY ("Open Banking") AND PUBYEAR > 2015 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "ENGI")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "cr"))	151 documents
3. Quality assessment	TITLE-ABS-KEY ("Open Banking") AND PUBYEAR > 2015 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "ENGI")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "cr")) AND (LIMIT-TO (SRCTYPE, "j"))	93 documents
Source type restrictions	TITLE-ABS-KEY ("Open Banking") AND PUBYEAR > 2015 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "COMP") OR LIMIT-TO (SUBJAREA, "BUSI") OR LIMIT-TO (SUBJAREA, "ECON") OR LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "DECI") OR LIMIT-TO (SUBJAREA, "ENGI")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp") OR LIMIT-TO (DOCTYPE, "cr")) AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (LANGUAGE, "English"))	89 documents
4. Data extraction	A "csv" format data file of 89 Journal articles, published in the English language, between 2016 and 2023	

Note: Source: authors' own, based on the OB bibliographic data extracted from the Scopus database on June 22, 2024.

TABLE A2: Top 30 most impactful/relevant documents in the open banking (OB) knowledge space.

Paper	DOI	Total citations	TC per year	Normalized TC
ZETZSCHE DA, 2020, J FINANC REGUL	10.1093/jfr/fjaa010	164	32.8	6.64864865
WANG H, 2020, FUTURE GENER COMPUT SYST	10.1016/j.future.2019.09.010	65	13	2.63513514
CHAN R, 2022, INT J BANK MARK	10.1108/IJBM-08-2021-0397	64	21.3333333	10.2937063
BUCKLEY RP, 2020, J BANK REGUL	10.1057/s41261-019-00104-1	40	8	1.62162162
ASHOFTEH A, 2021, EXPERT SYS APPL	10.1016/j.eswa.2021.114835	36	9	6.41584158
RAMDANI B, 2020, INT J INNOV TECHNOL MANAGE	10.1142/S0219877020500339	23	4.6	0.93243243
DRATVA R, 2020, ELECTRON MARK	10.1007/s12525-020-00403-w	21	4.2	0.85135135
MANSFIELD-DEVINE S, 2016, COMPUT FRAUD SECUR	10.1016/S1361-3723(16)30080-X	20	2.22222222	1
LIAO C-H, 2022, FUTURE GENER COMPUT SYST	10.1016/j.future.2022.05.015	19	6.33333333	3.05594406
HE Z, 2023, J FINANC ECON	10.1016/j.jfineco.2022.12.003	19	9.5	7.71875
SIVATHANU B, 2019, INF RESOUR MANAGE J	10.4018/IRMJ.2019070102	15	2.5	1.875
BARROS PENA B, 2021, PROC ACM HUM COMPUT INTERACT	10.1145/3432917	13	3.25	2.31683168
BORGOGNO O, 2020, EUR BUS LAW REV		11	2.2	0.44594595
OMARINI A, 2020, FRONTIER ARTIF INTELL	10.3389/frai.2020.00063	11	2.2	0.44594595
GRASSI L, 2022, FINANCIAL INNOV	10.1186/s40854-022-00378-x	11	3.66666667	1.76923077
BRATAAS G, 2021, J SYST SOFTWARE	10.1016/j.jss.2021.111064	10	2.5	1.78217822
PASSI LF, 2018, J PAYM STRATEG SYST		9	1.28571429	1.42105263
FARROW GSD, 2020, J PAYM STRATEG SYST		9	1.8	0.36486486
FRACASSI C, 2021, VANDERBILT LAW REV		9	2.25	1.6039604
BASSO A, 2018, REV IND ORGAN	10.1007/s11151-018-9668-2	8	1.14285714	1.26315789
IMAN N, 2023, INT J BANK MARK	10.1108/IJBM-09-2022-0427	8	4	3.25
FARROW GSD, 2020, J PAYM STRATEG SYST-a		8	1.6	0.32432432
ROSATI P, 2022, J THEOR APPL ELECTRON COMMER RES	10.3390/jtaer17020026	8	2.66666667	1.28671329
SAPULETTE MS, 2021, BUL EKON MONET PERBANK	10.21098/BEMP.V24I4.1470	6	1.5	1.06930693
RIAD K, 2022, WIRELESS COMMUN MOBILE COMPUT	10.1155/2022/3200891	6	2	0.96503497
KOLYCHEV A, 2019, J THEOR APPL INF TECHNOL		6	1	0.75
AHMED KAM, 2023, FUTURE INTERNET	10.3390/fi15060208	5	2.5	2.03125
KADYAN S, 2022, TRANSNATL MARK J	10.33182/tmj.v10i3.2295	5	1.66666667	0.8041958
MUTAMBIK I, 2023, SUSTAINABILITY	10.3390/su151410867	5	2.5	2.03125
ZETZSCHE DIRK, 2020, COMMON MARK LAW REV		5	1	0.2027027

Note: Source: authors' own, based on the OB bibliographic data extracted from the Scopus database on June 22, 2024.

TABLE A3: Study variables' descriptions.

Variable	Description
OBApp	The open banking (OB) approach adopted in the individual consumer's country of residence. A qualitative nominal variable with four levels (1—NA, no OB initiative; 2—MD, market-driven OB initiatives; 3—RO, regulatory-driven OB initiatives; 4—RP, Revised Payment Services Directive (PSD2)—regulated initiatives
SavBkAccFinInst12M	= 1 (otherwise 0) if an individual consumer reports having formally saved money in the 12 months prior to the data collection
DigitRemitt	= 1 (otherwise 0) if an individual consumer reports having used a mobile phone or the internet to send money to a friend or relative in the 12 months prior to the data collection
account_fin	= 1 (otherwise 0) if an individual consumer reports having a formal bank account with a financial institution
MobMoneyAcc	= 1 (otherwise 0) if an individual consumer reports using a mobile money account for a transaction in the 12 months prior to the data collection
DebitCard	= 1 (otherwise 0) if an individual consumer reports ownership of an automated teller machine (ATM) debit card
CreditCard	= 1 (otherwise 0) if an individual consumer reports ownership of a credit card
EmerFundAcesDif	The individual consumer's expressed difficulty accessing emergency funds (i.e., 5% of per capita gross national income, within a month time). Qualitative ordinal variable with three levels (1—very difficult; 2—somewhat difficult; 3—not difficult at all)
WagPaiRec12m	= 1 (otherwise 0) if an individual consumer reports any employment-related salary or wage payment in the 12 months prior (excludes payments from clients or customers for work done)
GovTransf12m	= 1 (otherwise 0) if an individual consumer reports any governmental support in the 12 months prior, for unemployment, education, medication (excludes work-related wages or salaries)
female	= 1 (otherwise 0) if an individual consumer identifies with the female gender
EducLev	Level of education achieved (1—at most primary; 2—secondary; 3—at least tertiary)
InLaborForce	= 1 (otherwise 0) if an individual consumer is active in the labor force
inc_q	The individual consumer's income quintile of belonging (based on household income before tax, includes also remittance receipts, farming income, salaries, and wages)
Age	The individual consumer's age measured in years
mobileown	= 1 (otherwise 0) if an individual consumer reports ownership of a mobile phone
InternAcces	= 1 (otherwise 0) if an individual consumer reports having access to the internet
UtBillsPaid12m	= 1 (otherwise 0) if an individual consumer reports having made any payment of utility bills in the 12 months prior
UrbanStat	= 1 (otherwise 0) if an individual consumer reports living in an urban area
country	The individual consumer's country of residence (see Figure 4)
Wgt	The individual consumer's within-country final weight in the study sample

Note: Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

TABLE A4: Quantitative summary description of the study variables.

<b>Quantitative factors</b>	<b>Units</b>	<b>Sample (N = 143,887)</b>	
		<b>Mean</b>	<b>Standard deviation</b>
Sampling weight (wgt)	—	1.00	0.81
Age	(In years)	41.05	17.32
<b>Qualitative factors</b>	<b>Levels</b>	<b>Absolute frequency</b>	<b>Relative frequency (%)</b>
OBApp	1: NA (ref.)	75,636	52.57
	2: MD	17,548	12.20
	3: RO	24,138	16.78
	4: RP	26,565	18.46
SavBkAccFinInst12M	1: yes	40,786	28.35
	0: no	103,101	71.65
DigitRemitt	1: yes	48,413	33.65
	0: no	95,474	66.35
account_fin	1: yes	94,390	65.6
	0: no	49,497	34.4
MobMoneyAcc	1: yes	21,525	14.96
	0: no	122,362	85.04
DebitCard	1: yes	72,945	50.70
	0: no	70,942	49.30
CreditCard	1: yes	32,634	22.68
	0: no	111,253	77.32
EmerFundAcesDif	1: very difficult (ref.)	54,471	37.86
	2: somewhat difficult	41,845	29.08
	3: not at all difficult	47,571	33.06
WagPaiRec12m	1: yes	55,016	38.24
	0: no	88,871	61.76
GovTransf12M	1: yes	27,707	19.26
	0: no	116,180	80.74
Female	1: yes	76,585	53.23
	0: no	67,302	46.77
EducLev	1: at most primary (ref.)	39,343	27.34
	2: secondary	72,401	50.32
	3: at least tertiary	32,143	22.34
InLaborForce	1: yes	92,659	64.4
	0: no	51,228	35.6
inc_q	1: lowest 20% (ref.)	23,353	16.23
	2: second 20%	24,880	17.29
	3: middle 20%	27,546	19.14
	4: fourth 20%	30,926	21.49
	5: highest 20%	37,182	25.84
mobileown	1: yes	126,695	88.05
	0: no	17,192	11.95
InternAcces	1: yes	100,970	70.17
	0: no	42,917	29.83
UtBillsPaid12m	1: yes	82,959	57.66
	0: no	60,928	42.34
UrbanStat	1: yes	31,781	22.09
	0: no	112,106	77.91

Note: "Ref." denotes the reference category for the corresponding categorical explanatory variable. Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

TABLE A5: Chi-square dependency test between the qualitative drivers and the dependent indicators of formal saving and digital remitting in the random utility-based conceptual framework in Figure 3.

Full sample (N = 143,887)	Categories	Chi <sup>2</sup> test			
		X -stat	SavBkAccFinInst12M p value	X -stat	DigitRemitt p value
OBApp	1: NA				
	2: MD				
	3: RO	21,088	<2.2 × 10 <sup>-16***</sup>	9170.7	<2.2 × 10 <sup>-16***</sup>
	4: RP				
SavBkAccFinInst12M	1: yes	—	—	16,201	<2.2 × 10 <sup>-16***</sup>
	0: no				
DigitRemitt	1: yes	16,201	<2.2 × 10 <sup>-16***</sup>	—	—
	0: no				
account_fin	1: yes	25,977	<2.2 × 10 <sup>-16***</sup>	14,865	<2.2 × 10 <sup>-16***</sup>
	0: no				
MobMoneyAcc	1: yes	4.3419	= 0.0372*	12,304	<2.2 × 10 <sup>-16***</sup>
	0: no				
DebitCard	1: yes	27,076	<2.2 × 10 <sup>-16***</sup>	18,449	<2.2 × 10 <sup>-16***</sup>
	0: no				
CreditCard	1: yes	19,814	<2.2 × 10 <sup>-16***</sup>	11,645	<2.2 × 10 <sup>-16***</sup>
	0: no				
EmerFundAcesDif	1: very difficult				
	2: somewhat difficult	22,511	<2.2 × 10 <sup>-16***</sup>	11,262	<2.2 × 10 <sup>-16***</sup>
	3: not at all difficult				
WagPaiRec12M	1: yes	11,898	<2.2 × 10 <sup>-16***</sup>	13,432	<2.2 × 10 <sup>-16***</sup>
	0: no				
GovTransf12M	1: yes	2028.1	<2.2 × 10 <sup>-16***</sup>	2023.4	<2.2 × 10 <sup>-16***</sup>
	0: no				
Female	1: yes	692.82	<2.2 × 10 <sup>-16***</sup>	860.75	<2.2 × 10 <sup>-16***</sup>
	0: no				
EducLev	1: at most primary				
	2: secondary	14942	<2.2 × 10 <sup>-16***</sup>	14,012	<2.2 × 10 <sup>-16***</sup>
	3: at least tertiary				
InLaborForce	1: yes	1160.5	<2.2 × 10 <sup>-16***</sup>	3086.6	<2.2 × 10 <sup>-16***</sup>
	0: no				
inc_q	1: lowest 20%				
	2: second 20%				
	3: middle 20%	4075.5	<2.2 × 10 <sup>-16**</sup>	4082.4	<2.2 × 10 <sup>-16***</sup>
	4: fourth 20%				
	5: highest 20%				
mobileown	1: yes	4346.6	<2.2 × 10 <sup>-16***</sup>	6280.2	<2.2 × 10 <sup>-16***</sup>
	0: no				
InternAcces	1: yes	12,014	<2.2 × 10 <sup>-16***</sup>	13,329	<2.2 × 10 <sup>-16***</sup>
	0: no				
UtBillsPaid12m	1: yes	8050.8	<2.2 × 10 <sup>-16***</sup>	3683.3	<2.2 × 10 <sup>-16***</sup>
	0: no				
UrbanStat	1: yes	6410.6	<2.2 × 10 <sup>-16***</sup>	3744.5	<2.2 × 10 <sup>-16***</sup>
	0: no				
Country	139 country factor levels	36,790	<2.2 × 10 <sup>-16***</sup>	33,679	<2.2 × 10 <sup>-16***</sup>

Note: Asterisks denote significance levels, with \* indicating significance at alpha 0.05, \*\* indicating significance at 0.01, and \*\*\* indicating significance at 0.001 for the chi-square test. Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

TABLE A6: Levine's test examining the homogeneity of variance among age-based groups.

			Age
SavBkAccFinInst12M	df.		1
	F-stat.		18.05
	p-val.		$= 2.153 \times 10^{-5}***$
DigitRemitt	df.		1
	F-stat.		3158.5
	p-val.		$<2.2 \times 10^{-16}***$

Note: Asterisks denote significance levels, with \* indicating significance at alpha 0.05, \*\* indicating significance at 0.01, and \*\*\* indicating significance at 0.001 for the Levine's test. H<sub>01</sub>: equal age variance between the group of consumers "that formally saved" and those "that did not"; H<sub>02</sub>: equal age variance between the group of consumers "that digitally remitted" and those "that did not"; in each of the above three null hypotheses (H<sub>01</sub>-H<sub>02</sub>), the alternative is H<sub>a</sub>: unequal group variances. Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

TABLE A7: Welch's two-sample *t*-test assessing the disparity in means between groups, accompanied by the associated 95% confidence interval (CI).

			Age
SavBkAccFinInst12M	Group mean values	No	39.90
		Yes	43.97
	Disparity in means between groups 95% CI on the group means difference <i>p</i> value		4.07*** (3.877; 4.267) $<2.2 \times 10^{-16}$
DigitRemitt	Group mean values	No	42.14
		Yes	38.90
	Disparity in means between groups 95% CI on the group means difference <i>p</i> value		−3.24*** (−3.426; −3.070) $<2.2 \times 10^{-16}$

Note: Asterisks denote significance levels, with \* indicating significance at alpha 0.05, \*\* indicating significance at 0.01, and \*\*\* indicating significance at 0.001 for welch *t*-test. Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

TABLE A8: Estimated coefficients of open banking's impact on individual consumers' derived marginal utility (or joint conditional likelihood) from formal saving and digital remitting in the global economy.

<i>N</i> = 143,887		Spatial parametric specification SavBkAccFinInst12M	DigitRemitt	Spatial semiparametric specification SavBkAccFinInst12M	DigitRemitt
(Intercept)		-2.862*** (0.054)	-2.186*** (0.091)	-2.940*** (0.052)	-2.706*** (0.092)
OBApp	2: MD	0.364** (0.127)	0.532* (0.246)	0.370** (0.126)	0.526* (0.249)
	3: RO	0.086 (0.109)	0.392* (0.210)	0.085 (0.108)	0.391* (0.213)
	4: RP	0.619*** (0.151)	0.561* (0.295)	0.618*** (0.151)	0.567* (0.298)
account_fin	1: yes	1.020*** (0.018)	0.300*** (0.016)	1.021*** (0.018)	0.297*** (0.016)
MobMoneyAcc	1: yes	0.281*** (0.016)	1.024*** (0.014)	0.276*** (0.016)	1.022*** (0.014)
DebitCard	1: yes	0.225*** (0.013)	0.360*** (0.014)	0.229*** (0.013)	0.350*** (0.012)
CreditCard	1: yes	0.211*** (0.011)	0.271*** (0.012)	0.215*** (0.011)	0.269*** (0.012)
EmerFundAcesDif	2: somewhat difficult	0.321*** (0.012)	0.157*** (0.011)	0.320*** (0.012)	0.158*** (0.011)
	3: not at all difficult	0.632*** (0.012)	0.229*** (0.012)	0.632*** (0.012)	0.231*** (0.012)
WagPaiRec12M	1: yes	0.176*** (0.010)	0.187*** (0.010)	0.184*** (0.011)	0.176*** (0.010)
GovTransf12M	1: yes	0.045*** (0.011)	0.109*** (0.011)	0.046*** (0.011)	0.106*** (0.011)
Female	1: yes	0.003 (0.009)	-0.021* (0.009)	0.006 (0.009)	-0.027** (0.009)
EducLev	2: secondary	0.086*** (0.012)	0.137*** (0.012)	0.085*** (0.012)	0.132*** (0.012)
	3: at least tertiary	0.270*** (0.159)	0.392*** (0.016)	0.276*** (0.016)	0.376*** (0.016)
InLaborForce	1: yes	0.086*** (0.011)	0.126*** (0.011)	0.108*** (0.012)	0.096*** (0.011)
inc_q	2: second 20%	0.084*** (0.015)	0.071*** (0.014)	0.083*** (0.015)	0.072*** (0.011)
	3: middle 20%	0.147*** (0.015)	0.120*** (0.014)	0.144*** (0.015)	0.123*** (0.014)
	4: fourth 20%	0.195*** (0.015)	0.169*** (0.014)	0.192*** (0.015)	0.172*** (0.014)
	5: highest 20%	0.296*** (0.015)	0.256*** (0.015)	0.290*** (0.015)	0.262*** (0.015)
mobileown	1: yes	0.046* (0.020)	0.392*** (0.019)	0.055** (0.020)	0.373*** (0.015)
InternAcces	1: yes	0.116*** (0.015)	0.359*** (0.014)	0.119*** (0.015)	0.361*** (0.014)
UtBillsPaid12m	1: yes	0.119*** (0.010)	0.131*** (0.010)	0.128*** (0.010)	0.119*** (0.010)

TABLE A8: Continued.

<i>N</i> = 143,887		Spatial parametric specification		Spatial semiparametric specification	
		SavBkAccFinInst12M	DigitRemitt	SavBkAccFinInst12M	DigitRemitt
UrbanStat	1: yes	0.044** (0.017)	-0.064*** (0.015)	0.046** (0.017)	-0.066*** (0.014)
Age		-0.001** (0.0003)	-0.014*** (0.0003)	<i>p</i> val < $2 \times 10^{-16}***$ (edf = 3.911)	<i>p</i> val < $2 \times 10^{-16}***$ (edf = 7.453)
Country		<i>p</i> val < $2 \times 10^{-16}***$ (edf = 131.8)	<i>p</i> val < $2 \times 10^{-16}***$ (edf = 134.3)	<i>p</i> val < $2 \times 10^{-16}***$ (edf = 131.800)	<i>p</i> val < $2 \times 10^{-16}***$ (edf = 134.273)
$\hat{\theta}_{SR}$		0.161 (0.147, 0.175)		0.162 (0.149, 0.173)	
AIC		214,680.6		214,484.9	
BIC		217,812.5		217,709.0	
Largest absolute gradient		$2.17 \times 10^{-4}$		$1.67 \times 10^{-5}$	
Eigenvalue range		[0.5417, 109,938,810]		[0.5296, 362,384.1]	

Note: Values enclosed in parentheses include the standard error (s.e.) of the coefficients and the 95% confidence intervals (CI) on  $\hat{\theta}$ . Asterisks denote significance levels, with \* indicating significance at alpha 0.05, \*\* indicating significance at 0.01, and \*\*\* indicating significance at 0.001. Source: authors' own, based on data from the second update of the 2021–2022 wave of the Global Findex survey.

## Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Conflicts of Interest

The authors declare no conflicts of interest.

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## Endnotes

<sup>1</sup>Given that “utility” gauges the satisfaction experienced by economic actors through their choices across diverse economic frameworks, the “total utility” stemming from formal saving and digital remittance represents the overall satisfaction derived by the representative consumer from both formally depositing money and digitally transferring funds (via mobile phone or the internet) to a friend or family member. The ascertained “marginal utilities” from these financial activities are presently construed as the alterations in total satisfaction that the representative consumer undergoes when transitioning from a state of neither formal saving nor digital remittance to actively engaging in these practices in the era of open banking.

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