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The Influence of Innovation on Corporate Sustainability in the International Banking Industry

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Abstract: We empirically explore the innovation and corporate sustainability link using a large sample of worldwide banks for the period 2003–2016. Our results suggest that service innovation performance enhances the banking industry's corporate sustainability. In addition, we contribute by proposing a conceptual framework for understanding the link between innovation performance and corporate sustainability in the banking industry. The framework consists of three underlying dimensions—the antecedents of innovation performance, the specific innovation performance initiatives, and how these initiatives are converted into improved corporate sustainability. Our findings provide insights for academics and practitioners on the dynamics between service innovation performance and corporate sustainability in the banking sector. Further, due to the intermediation role of banks in the economy, their evolution towards sustainable banking constitutes a lever for sustainability across other industries and overall sustainable development.

1. Introduction

In the banking sector, service innovation performance and corporate sustainability constitute two key elements that shape the industry's evolution. Corporate sustainability aims to balance economic responsibilities with social and environmental ones [1,2]. Banks' difficult position following the 2008 financial crisis caused a substantial interest in sustainability as a means to restore damaged reputations [3–5]. Additionally, innovations allow the introduction of a new product, service or process to the market [6,7]. In particular, a service innovation is understood as a novel service concept that offers new value-added to customers [8]. Innovative strategies have become imperative to compete in the financial industry. For example, in 2015, half of European banking customers performed their financial transactions through digital channels. While the antecedents of innovation in finance have been well examined by the literature (e.g., [9–11]), this paper aims to address a particular output of the innovation process, i.e., the influence of service innovation performance on corporate sustainability. Moreover, our goal is to advance the understanding of the interrelation between service innovation performance and corporate sustainability in the banking sector.

Extant literature has shown the relationship between innovation performance and corporate sustainability as a combination of economic, social and environmental goals [1,12–15]. Innovation is key to both manufacturing and service industries. However, most studies on the relationship between corporate sustainability and innovation performance build on manufacturing companies and eco-innovations [16–20]. Samples in this stream of literature typically exclude the financial sector

(i.e., [21]) because of its limited direct environmental impact. However, banks have an important responsibility when allocating funds to companies that pollute and produce unsafe products [22]. Nevertheless, only a few studies have approached innovation within the banking sector (i.e., [23,24]). To our knowledge, there is no research that looks at service innovation performance and corporate sustainability jointly with the recent exception of [25] for the Hong Kong retail banking industry.

To fill that important gap and contribute to the corporate sustainability literature, the aim of this paper is to provide insights on how service innovation performance influences corporate sustainability in the international banking sector. We test our hypothesis for a sample of 168 banks in 14 countries over the period 2003–2016. The results confirm that innovation performance fosters corporate sustainability in the banking sector. Moreover, we propose a framework that allows mapping the antecedents and specific articulations of innovation performance and how these drive superior banks' corporate sustainability. Insights from this industry can be useful for other industries, in particular service industries. Moreover, our findings yield interesting implications for financial services users, businesses, and legislative bodies.

2. Innovation Performance That Fosters Corporate Sustainability in the Banking Industry

2.1. The Instrumental Value of Innovation Performance and Corporate Sustainability

Innovation is 'the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace' ([26], p. 1334). We build on this general and integrative definition of innovation in order to theorize about its relationship with corporate sustainability in the services sector, particularly the banking sector. This allows us to encompass different perspectives of innovation, such as technological, organizational, and business-model innovation. In turn, corporate sustainability is a multidimensional construct [27] which can be associated to the Environmental, Social and Governance (ESG) pillars (i.e., [28]). From an organizational perspective, corporate sustainability is connected to the extent to which people and product quality meet the economic, social and governance dimensions [29]. From a macro perspective, corporate sustainability has been linked to the effects that firms can provide on society when playing a state role and substituting the functions of governments [30–32]. Macro and micro level perspectives meet as companies are urged to act on society's grand–challenges [33,34]. Additionally, the literature tends to confront the organizational (i.e., instrumental) vs. the normative view. For the purposes of this article, we build on the organizational perspective in order to analyse the influence of service innovation performance on corporate sustainability's ESG dimensions, under an instrumental view of corporate sustainability.

Both service innovation and corporate sustainability share some common features in terms of their consequences for the firm [26]. In particular, corporate sustainability outcomes addressed by decades of studies highlight its connection with corporate performance [35,36], differentiation strategies [37–39], and the creation of other competitive advantages through intangible strategic resources such as reputation [40,41]. Innovation can generate internal outcomes such as differentiation from competitors [42], first-mover advantages [43] or adaptation to new market conditions [44]. According to the service innovation theory, key to service innovation is the capability to align users' needs and the relevant technological options [45]. Accordingly, innovations within the financial industry allow firms to better serve existing clients and access new customer segments. Thereafter, these regular innovations reduce the cost of financial intermediation [46], increase customer loyalty [47] and allow differentiation from industry rivals [48,49]. This is crucial because intangible services are difficult to set apart from competitors [50] and present low barriers to imitate them [51]. Moreover, in terms of implementation, both service innovation and corporate sustainability rely on organizational transformation and change [52]. Yet, innovative firms do not automatically become sustainable and vice-versa, although they can converge in the case of sustainable innovation [53–55].

Based on the above considerations, Figure 1 depicts a conceptual framework for understanding the influence of service innovation performance on corporate sustainability in the banking industry. The framework shows three separated blocks that pertain to (i) antecedents of innovation performance; (ii) innovation performance initiatives; and, (iii) innovation performance as a driver of superior corporate sustainability. The following sections detail the different components of the proposed framework.
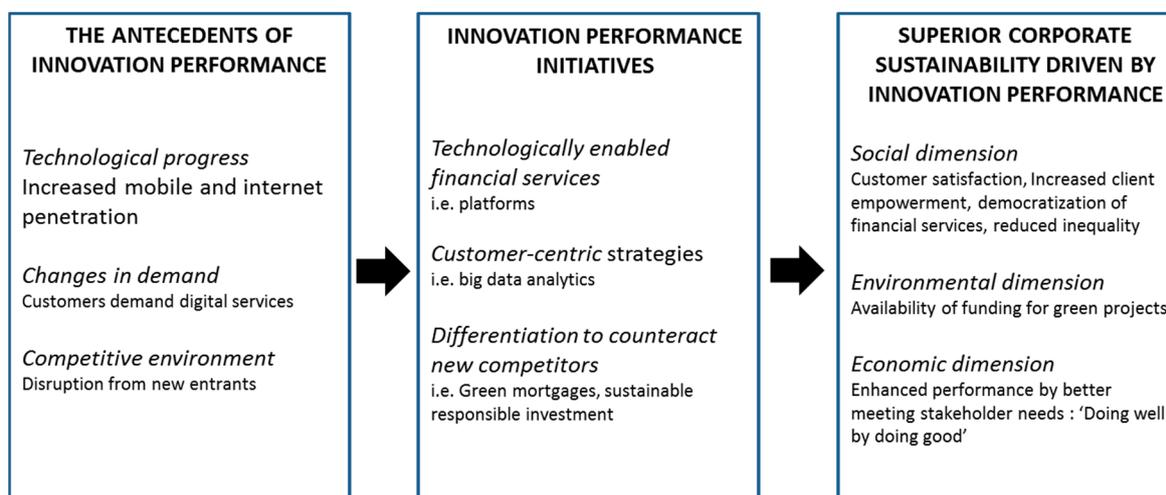
THE ANTECEDENTS OF INNOVATION PERFORMANCE	**INNOVATION PERFORMANCE INITIATIVES**	**SUPERIOR CORPORATE SUSTAINABILITY DRIVEN BY INNOVATION PERFORMANCE**
Technological progress Increased mobile and internet penetration	*Technologically enabled financial services* i.e. platforms	*Social dimension* Customer satisfaction, Increased client empowerment, democratization of financial services, reduced inequality
Changes in demand Customers demand digital services	*Customer-centric* strategies i.e. big data analytics	*Environmental dimension* Availability of funding for green projects
Competitive environment Disruption from new entrants	*Differentiation to counteract new competitors* i.e. Green mortgages, sustainable responsible investment	*Economic dimension* Enhanced performance by better meeting stakeholder needs : 'Doing well by doing good'

Figure 1. A conceptual framework for understanding the influence of service innovation performance on corporate sustainability in the banking industry.

2.2. Antecedents of Innovation Performance in the Banking Industry

In the particular case of the banking industry, we have identified the value of technological progress, changes in demand that urge a customer-centric orientation, and differentiation from new entrants as antecedents of innovative performance. Information technologies have forced the most extensive strategic transformation in banks' history from a "brick-and-mortar" to "click-and-mortar" banking model [56], where innovation performance has been key to delivering banks' multichannel approach. This process encompasses the offering of traditional banking products adapted to new distribution channels in addition to traditional branches. Taking a step forward, the financial industry is radically changing its value proposition to deliver ad-hoc financial services based on customer preferences. These innovations involve dramatic changes to the organizational structure, seeking to open up new markets and/or extending and replacing products [57]. In this manner, as innovation can be demand-driven, banks respond to the shift in consumer attitude that demands full digital access to services and broad institutional change derived from growing internet penetration.

The competitive scenario is another trigger for banks' innovative strategies due to disruptive new entrants [56] that are not necessarily traditional incumbents, for example, online retailers, telecoms, or other companies with access to a large client-base. This process is changing industry boundaries by moving from "rule makers" or market leaders to "rule breakers" [24]. This disintermediation challenge accelerates the pace of innovation within the banking industry [25]. Another strategy that faces this new wave of competitors is based on innovation from absorptive capacity [58]. This suggests that relying on external sources of knowledge also benefits firms' innovative capacity [59], for example through banks' investments or alliances in financial start-ups or 'fintech' (financial technology) companies [60].

As a result, and due to technological and demand changes, firms need to innovate as an attempt to adapt to the rapidly evolving competitive environment [61] and uphold their competitiveness [62].

2.3. Innovation Performance Initiatives in the Banking Industry

Service innovation is not only considered a priority to attain competitive advantages [63] or to face the consequences of disruption [24]. It also represents an effective means to better meet

growing stakeholder demands [63], improve social welfare and achieve better recognition for corporate sustainability [64] which encompasses stakeholder well-being [65]. Thus, the adoption of innovation includes instrumental and non-instrumental factors [66]. As we argued before, from a market-based approach, instrumental innovation aims to attain firm objectives. In contrast, the non-instrumental prioritizes positive impacts on external stakeholders [67]. For that reason, some innovation initiatives can yield social and environmental side effects that may either benefit or provide unintended consequences for several stakeholders, whilst some innovation can be oriented to improve corporate sustainability as a main objective. Thus, we discuss the effects of these counteracting and conflicting forces resulting from the innovative activity of banks on corporate sustainability.

Innovative strategies in the banking sector may lead to an enhancement of firms' sustainable profile [63] by promoting new ventures to deal with social and environmental problems [64]. Examples of specific service innovation performance initiatives include low-cost digital channels and easy-to-use transactional platforms (computers, mobile phones and other related devices) that increase transparency and usage. For example, the significant increase in the use of mobile phones to conduct financial transactions in developing countries has contributed to a rise in the share of digital payments from 50% to 70% in 2017 (World Bank). In this manner, the democratization of access to banking services expands financial well-being for individuals and societies [68]. Additionally, innovations derived from the use of big data analytics allow better assessment of client needs, providing customized services in alignment with risk profiles and investors' preferences [69]. These innovations lead to customer-centric strategies that facilitate access, increase price transparency and thus empower clients [70]. Other financial innovations such as green mortgages associated with real estate energy efficiency or socially responsible investment funds may also derive improved corporate sustainability appraisals [71]. Thus, innovations in services that better meet client requirements may result in significant outcomes for customer satisfaction and banks' corporate sustainability, conceptualized as fulfilling stakeholders' demands [72] and strengthening relations with customers [59].

2.4. The Influence of Innovation Performance on Corporate Sustainability in the Banking Industry

Innovation can turn into enhanced corporate sustainability by ([73], p. 444): '(1) Influencing inequalities, (2) supporting the creation of hybrid organisations, (3) promoting new business models for social objectives and for specific peripheral market segments, and finally (4) pushing towards new sustainable solutions for the environment'. Following this categorization, and by improving innovation performance, banks attain a superior corporate sustainability based on a combination of: (i) Increased customer orientation by adapting to new demands from clients, (ii) technologically-enabled financial services that allow servicing peripheral/untapped markets and banking the unbanked and, (iii) differentiation to counteract disruption from new incumbents.

Innovation has the potential to transform the banking industry by leading to superior corporate sustainability on various domains. As regards to the social dimension of corporate sustainability, more transparent and accessible financial services may deliver growing customer financial empowerment, thus becoming a suitable carrier of positive social impacts from service innovation. Also, digitally enabled innovations address financial needs via platforms [69] which brings the potential to reduce costs and reach a wider number of clients and markets [46] by creating novel market proposals [11]. From the environmental dimension perspective, innovation may increase the availability of funding for green projects, for instance, by developing technologies that allow the incorporation of environmental risk assessments into credit decisions [74]. Finally, service innovation in banks may incorporate corporate sustainability features compatible with enhanced economic performance [75]. For example, disruption from new competitors in the financial services arena (Fintech companies) has driven financial companies to innovate in order to gain a competitive advantage [76]. In response to stronger competition, banks innovate on customer-centric initiatives [77] and stakeholder orientation to differentiate from new entrants. This involves increased interaction with clients and society through different channels [78], therefore, better meeting stakeholders' needs.

On the contrary, one can make the case for potential negative influences of banks' innovation on corporate sustainability. For example, financial innovations through digital platforms or robo-advisors and passive asset management may result in employee layoffs, and big data analytics may cause data breaches and privacy risk [79]. In addition, a branch-less environment may increase customers' perception of risk, uncertainty and technological resistance, as found by [80] regarding the initial low acceptance of mobile banking. The extended use of digital currencies as an anonymous transaction system may attract criminality and ease money-laundering [81]. Similarly, electronic trading practices translate into a higher risk across financial markets [82].

From the discussion above, we consider that the balance of the different effects of service innovation performance on corporate sustainability is positive. For that reason, we propose the following hypothesis:

Hypothesis 1. *Banks' innovation performance positively influences corporate sustainability.*

2.5. Operationalization of the Hypothesis

Corporate sustainability and service innovation performance constitute the focus of interest in this research, measured as follows. Corporate sustainability has been proxied by the scores on Environmental, Social and Governance (ESG) dimensions from Thomson Reuters [83,84] based on more than 280 key performance indicators. We find this measure suitable for our purposes as corporate sustainability is a multidimensional construct that involves environmental, social, and economic factors [27]. In addition, the ESG scores provide a continuous measure as opposed to other available dichotomous indicators (e.g., sustainable/not sustainable). Nevertheless, ESG ratings are not free of limitations. For example, [85] argue that most providers of ESG do not integrate the main principles of sustainability, including the intergenerational perspective (i.e., rating of current and also future risks).

The available empirical evidence about innovation in the financial sector is scarce [86,87] as its measurement is challenging. Banks rarely have R&D budgets, though they do have IT budgets. In addition, patents for financial products and services are not common. However, we are interested in a wider notion of innovation, based on the Schumpeterian view [87] that innovation is not limited, for example, to the capacity to deliver new products, but also includes the economic contribution of those new products [88]. Therefore, success will have economic significance reflected in lower costs and higher performance. In this vein, we build on the premise that service innovation within the financial industry leads to efficiency or productivity gains through cost reductions [85,89,90]. While we cannot measure the innovation effort, we focus on the effect that service innovation exerts on cost-efficiencies by estimating banks' technology gap. This technology gap ratio (See Appendix A) constitutes our measure of innovation performance (*INN*) ranging from 0–1. Since highly innovative banks are technology leaders, their innovation performance measured by the technology gap ratio tends to one and vice-versa. The measurement of innovation performance should be scale-based to ensure validity and reliability [91]. Thus, the technology gap ratio values the different degrees of advancement in innovation, which is a continuous process [92], especially in the services industry. Also, the variable is lagged one period [62,93], in order to allow innovative efforts to display an effect on corporate sustainability or post-innovation corporate sustainability effects [94].

3. Methods

3.1. Sample and Variables

We have estimated an unbalanced data panel of 168 banks in 14 countries and 938 observations, over the period 2003–2016 (see Appendix B on sample distribution by country). As stated above, service innovation performance is proxied to banks' technology gap ratio whereas corporate sustainability is measured based on ESG disclosure.

Our model incorporates several control variables, sourced from Thomson Reuters, because of their potential effect on corporate sustainability. Economic returns, measured by return on average assets (*ROA*) are included in our model as a control variable [95,96]. ROA is an appropriate indicator of banks' profitability [22]. Balance sheet quality is of key importance within the banking sector [97] because it signals solvency. As such we are including the Tier1-capital adequacy ratio in our equation (*TIER-1*), in line with [98]. Banks' solvency is an essential criterion which includes board members' reputation [99]. Non-performing-loans (*NPL*) are also included in our model as a risk factor, specifically tailored to the banking industry [22]. The variable (*Loans*) is the natural logarithm of total loans (commercial, industrial, real estate, consumer and other outstanding credits). This variable controls for potential size effects as the core business of retail banks is transforming assets into customer lending [22].

Macroeconomic factors are specifically relevant to the banking sector due to the cyclical nature of its business [100]. We include the natural logarithm of Gross Domestic Product (*GDP*) and the percentage evolution of GDP annually (*Growth*), both gathered from the World Bank. The former measures the size of the local potential market. The latter is positively associated with banks' performance, which in turn influences corporate sustainability [94,101].

The relationship between corporate sustainability and service innovation performance raises a problem of bidirectional causality [63,93]. Sustainability may trigger innovation performance [102–104], yet, innovations may influence sustainability as innovative firms are more flexible and therefore better able to adopt corporate sustainability practices [93,105]. This bidirectional causality poses a potential endogeneity issue that can bias the results. Moreover, corporate sustainability practices have been found to have an impact on corporate performance [35], which brings into question the exogeneity of the control variables associated with performance (*ROA*, *Tier-1*, *NPL*, *Loans*). We have therefore lagged all potentially endogenous variables one period. In addition, to correct the endogeneity we have incorporated two exogenous instrument variables: The percentage of internet users over total population (*Internet*) and the percentage of mobile cellular telephone subscriptions over total population (Idem) (*Mobile*), both sourced from the World Bank database. These variables may influence banks' decisions on innovation [46], but should not have a direct impact on their corporate sustainability practices.

3.2. Model Specification

We empirically test the influence that service innovation performance exerts on banks' corporate sustainability over the period 2003–2016. The process towards corporate sustainability often involves the development of new knowledge and capacities. This process is sequential and needs time, therefore, the generation of corporate sustainability is path-dependent [106]. A dynamic panel data allows the consideration of this path dependence, in which the different variables are lagged one period:

$$CS_{ijt} = \gamma_1 CS_{ijt-1} + \gamma_2 INN_{ijt-1} + XF'_{ijt-1}\beta_1 + XC'_{ijt}\beta_2 + \zeta_j + \theta_t + \varepsilon_{ijt} \tag{1}$$

where CS_{ijt-1} represents corporate sustainability, INN_{ijt-1} is the service innovation performance measured by the technology gap ratio of each bank; XF'_{ijt-1} is the vector of banks' control variables, which includes *ROA*, *Tier-1*, *NPL* and *Loans*; XC'_{ijt} is the vector of context control variables, which includes *GDP* and Growth, a dummy for each country (ζ_j) and for each year (θ_t); ε_{ijt} is the random error. The sample shows heteroskedasticity autocorrelation within individuals but not across them, which is corrected by using the "sandwich" kernel-based estimator.

We empirically tested our hypothesis by applying the one-step and two-step generalized method of moments estimator (GMM) with Forward Orthogonal Deviation (FOD) and the two instrument variables (*Internet* and *Mobile*) [107–109].

4. Results

Table 1 shows the descriptive statistic, whereas the correlation matrix in Table 2 reveals no multicollinearity problems.

Table 1. Descriptive statistics.

Variables	Obs.	Mean	S.D.	Median	Min.	Max.	Skewness	Kurtosis
CS	938	55.683	21.851	54.356	54356	94.894	0.029	1.591
INN	938	0.971	0.020	0.977	0.842	0.997	−2.342	10.903
ROA	938	0.007	0.007	0.008	−0.058	0.045	−2.118	16.005
TIER-1	938	0.116	0.035	0.113	0.051	0.379	2.228	14.070
Loans	938	24.686	1.824	24.776	19.644	27.831	−0.383	2.401
NPL	938	0.046	0.113	0.016	0.000	1.047	6.175	46.010
Internet	938	0.835	0.089	0.850	0.441	0.973	−1.672	8.614
Mobile	938	1.017	0.241	1.072	0.469	1.565	−0.677	2.430

Table 2. Correlation matrix.

	CS_{t-1}	INN_{t-1}	ROA_{t-1}	NPL_{t-1}	$Tier1_{t-1}$	$Loans_{t-1}$	GDP_t	$Growth_t$	$Internet_t$	$Mobile_t$
CS_{t-1}	1.000									
INN_{t-1}	−0.040	1.000								
ROA_{t-1}	−0.170	−0.013	1.000							
NPL_{t-1}	0.105	0.020	−0.238	1.000						
$Tier1_{t-1}$	−0.095	0.073	0.010	0.041	1.000					
$Loans_{t-1}$	0.683	−0.004	−0.229	0.045	−0.267	1.000				
GDP_t	−0.343	0.030	0.212	−0.266	−0.057	−0.267	1.000			
$Growth_t$	−0.031	−0.100	0.392	−0.216	0.028	−0.100	0.119	1.000		
$Internet_t$	−0.083	0.082	0.164	−0.207	−0.158	0.156	0.343	0.153	1.000	
$Mobile_t$	−0.219	0.066	0.131	−0.203	−0.073	0.050	0.028	0.088	0.579	1.000

Table 3 shows the results of our estimations. Models 1 and 2, estimated in one-step and two-step respectively, show very similar results (Table 3). The coefficient of INN_{ijt-1} is positive and significant. This result confirms a positive impact of *INN* on corporate sustainability, providing support to our hypothesis. The coefficient of *Loans* is positive and significant, suggesting a linkage between banks' size and corporate sustainability. However, the coefficients of *ROA*, *NPL* and *Tier-1* are non-significant. Finally, *GDP* has a positive impact on corporate sustainability, thus confirming that banks headquartered in large countries are more concerned about social and environmental issues. By contrast, *Growth* delivers a negative impact on corporate sustainability, suggesting that in expansionary periods companies are less enthusiastic about corporate sustainability.

The complexity of the GMM estimators can easily generate invalid estimations [110], therefore a robustness analysis is necessary. Table 4 presents our robustness tests, where the GMM-FOD model with exogenous instrument variables has been estimated by applying the collapse technique but without limiting the number of lags for instruments. Therefore, the number of instruments increases to 157, resulting in a significant and positive coefficient of innovation performance in both the one-step and the two-step estimation (Models 3 and 4). In addition, we have excluded two instrumental variables and we have estimated the GMM-FOD with limited lags and the collapse technique. In this case, the number of instruments obtained is 83. This results in a positive and significant coefficient of *INN* in the one-step model (Model 5), and a positive but not significant coefficient in the two-step model (Model 6). Similar results are obtained when the number of lags for instruments is not limited (Model 7 and Model 8). We conclude that the model remains fairly robust.

Table 3. Innovation and corporate sustainability.

Variables	(1) CS_{ijt} GMM FOD One-Step	(2) CS_{ijt} GMM FOD Two-Step
CS_{ijt-1}	0.677 ****	0.684 ****
	(0.060)	(0.059)
INN_{ijt-1}	39.390 **	35.805 **
	(15.300)	(14.024)
ROA_{ijt-1}	−7.512	6.710
	(58.333)	(54.983)
NPL_{ijt-1}	−4.686	−4.245
	(3.482)	(5.314)
$Tier1_{ijt-1}$	0.598	−14.886
	(21.993)	(25.119)
$Loans_{ijt-1}$	2.807 ***	2.646 ***
	(1.046)	(0.931)
GDP_{jt}	6.782 *	8.552 **
	(3.447)	(3.397)
$Growth_{jt}$	−0.391	−0.508 **
	(0.250)	(0.234)
Constant	−174.529 ***	−189.634 ***
	(53.869)	(57.051)
Number of instruments	97	97
Included time dummies	Yes	Yes
Included country dummies	Yes	Yes
Arellano-Bond test for AR(1)	−5.710 ****	−4.910 ****
Arellano-Bond test for AR(2)	0.460	0.390
Hansen J test of overidentification	53.290	53.290
Observations	875	875
Number of banks	168	168

Standard errors in parentheses **** $p < 0.001$, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Instrument variables: Mobile and internet penetration.

Table 4. Robustness test.

GMM FOD Model	INN_{ijt-1}
Model 3: One step (collapse, instrumented)	36.468 **
Model 4: Two step (collapse, instrumented)	40.153 **
Model 5: One step (limited lags, collapse, no instrumented)	38.054 **
Model 6: Two step (limited lags, collapse, no instrumented)	23.584
Model 7: One-step (collapse, no instrumented)	35.934 **
Model 8: Two-step (collapse, no instrumented)	28.512

Standard errors in parentheses **** $p < 0.001$, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Instrument variables: Mobile and internet penetration.

5. Discussion and Conclusions

Our empirical results, for a sample of 168 banks over the period 2003–2016, show how innovation performance in the international banking sector can result in enhanced contribution to corporate sustainability. Thus, we provide empirical evidence on how service innovations enable the incorporation of social and environmental goals beyond existing regulation and thus lead to enhanced corporate sustainability. In this manner, our findings also contribute to the recent academic debate about the relevance of innovation for society's well-being and sustainable development [73]. Furthermore, our

results offer evidence that the relationship between corporate sustainability and service innovation performance is intense for those firms operating in highly competitive markets [104] and less munificent environments [21]. Indeed, the financial industry provides an ideal example of extreme competitive conditions, where banks face challenges arising from new entrants that provide financial services. We argued that there are some counteracting effects of service innovation performance on corporate sustainability. Nevertheless, our empirical results show how innovation performance improves banks' corporate sustainability, measured by the ESG ratings. Thus, the positive outcomes exceed the potential negative ones. This is coherent with corporate sustainability literature [104] and with innovation literature [110,111].

This study extends a strand of research explaining the influence of innovation performance on corporate sustainability [21,112,113]. In particular, our findings offer novel insights on innovation and corporate sustainability dynamics in the banking industry, making several contributions to this literature. First, we cover an important research gap in our knowledge, as no prior research empirically examines the effect that innovation performance may have on corporate sustainability in the international banking arena. To bridge this gap, we suggest a framework that links service innovation performance and corporate sustainability. Moreover, we provide evidence for a period of fourteen years on European and US banks, which is considered a sector leader in innovation [114]. The current digital transformation within the sector along with the growing relevance of sustainability-related issues creates important opportunities and challenges for the firms and their communities, which deserve appropriate academic attention. Thus, we further advance the understanding of corporate sustainability determinants. In particular, we address corporate sustainability as a multidimensional construct on the basis of environmental and social orientations, gauged as the ESG score. Moreover, from a broader perspective, the findings show a strong intersection between service innovation performance and corporate sustainability, suggesting an alignment between corporate goals and values.

Methodologically, we employ the stochastic frontiers model [89] as an approach to banks' innovation performance. Innovation within the financial sector has scarcely been analysed due to the limited availability of R&D data. In addition, our approach to innovation performance is company-oriented as opposed to the more common macroeconomic focused country innovation and digitization indices such as [115]. Also, the scale of service innovation we use, considered as a process or continuum [52] allows a sensitivity analysis of its effect on corporate sustainability, which is also graded as a continuous variable. According to our model, banks in our sample place themselves at different stages of innovation performance as estimated by the technology gap, which produces a positive effect on corporate sustainability with differentiated strengths. Finally, by analyzing the innovation dynamics underpinning corporate sustainability in finance, we contribute to the vibrant discussion on sustainability transitions and their wider effects on sustainable development.

Our study is limited by the constrained data about innovation provided by the banking industry. More fine-grained details may allow a deeper understanding of how technological investments have an impact on corporate sustainability. Further research may analyse digital giants disrupting the financial industry and compare their different sustainable innovation-related strategies. In addition, case studies through a multi-stakeholder approach can shed light on the nature and consequences of sustainable innovation. This research has considered the instrumental value of both service innovation performance and corporate sustainability. However, we acknowledge that corporate sustainability may follow ethical motivations and we encourage future analyses on the linkage between innovation performance and corporate sustainability from a normative perspective. Finally, future studies may focus on banks headquartered in emerging countries and on how the combination of innovation and corporate sustainability can be extended to other sectors, as the digital economy and sustainability challenges affect all industries.

These results have some managerial implications for banks. First, given the new competitive landscape and its accelerated pace of change, banks' managers can understand the importance of improving their innovation performance [60], and how it can help to strengthen their corporate

sustainability, as shown in our proposed framework. Second, the findings may strengthen banking sector support of the initiative led by the UN and the World Bank to enhance financial access, which needs a combination of innovation and corporate sustainability. Finally, from an instrumental perspective, our analysis and framework illustrate a combination of service innovation performance initiatives that may lead to stakeholder well-being and, simultaneously, to competitive advantages. Thus, the findings open the path for '*doing well by doing good*'.

Author Contributions: This article is a joint work of the three authors. F.J.F., E.A. and F.Ú. contributed to the research framework, literature review, empirical analysis and conclusions. All authors read and approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

To measure the technological gap, we draw on a production function for estimating a stochastic frontier, which defines the optimal cost of a bank. The technology gap is the ratio between the optimal costs (i.e., without inefficiencies) resulting from the innovation activity of a bank and the optimal costs of that bank when (hypothetically) positioned on the technological knowledge frontier [89,116]. To determine the technology gap, first we estimate a stochastic frontier for each country where the different banks are present, followed by a stochastic meta-frontier for the whole sample, applying the two-step methodology proposed by [117]. In the first step, the country-specific stochastic frontier is derived from a translog production function. This stochastic frontier determines the optimal costs (i.e., without inefficiencies) of bank i located in country j $\left[f_t^j\left(X_{ijt}\right) \right]$. In the second step, we estimate the stochastic meta-frontier $f_t^M\left(X_{ijt}\right)$, which represents the optimal costs of bank i when (hypothetically) positioned on the technological knowledge frontier. The ratio between both stochastic frontiers determines the technology gap ratio: $INN_{it}^j = \dfrac{f_t^M\left(X_{ijt}\right)}{f_t^j\left(X_{ijt}\right)}$. The country-specific frontier, the meta-frontier and the technology gap ratio have been estimated over a sample of 588 banks and 6675 observations.

Appendix B

Table A1. Sample distribution by country (2003–2016).

	Number of Banks	Observations
Australia	6	65
Austria	2	14
Canada	9	79
Denmark	3	15
France	4	26
Germany	2	12
Greece	4	17
Italy	9	78
Norway	1	12
Portugal	2	23
Spain	5	50
Switzerland	6	45
United Kingdom	6	71
United States of America	109	431
Total	168	938

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