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Agency conflicts in innovation adoption: Lessons from the airline industry

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ABSTRACT

Introducing an innovation does not end, but rather starts, with adoption. In fact, some innovations display network elements and require more than one firm to take them up in order to be successful and deliver the intended results. Such is the case of NDC (new distribution capability), an airline-fostered enhancement of the way air travel services are conveyed and distributed from carriers to travel agents. The promise behind NDC is that travel services will be sold more richly and within a more open and inclusive framework. We draw on the diffusion of innovations, institutional theory, and agency theory to review the determinants of adoption and its effects on performance for service providers. We use the International Air Transport Association (IATA) ticket database to establish the role that institutional pressure plays on innovation behaviours and firms' results. We find that institutional pressure, not just innovation attributes, influence outcomes. Also, given each player's different incentives and the asymmetry of information, ticket sales are selectively distributed in ways that fit the agent and only occasionally the airline principal. Thus, we conclude that travel intermediaries assess outcomes wholistically and that the innovation's revenue uplift depends on such assessment.

Introduction

The diffusion of technology-related innovations, when such diffusion occurs at the organisational level and users are mandated externally, makes for a complex, little-analysed setting in which one should reconcile the source of the adoption decision and the subject of its utilisation, which do not always align (Gallivan, 2001). These adoption challenges increase when we move from within the organisation to an industry or inter-firm case as the absence of hierarchies makes adoption reliant on other factors in order for the innovation to be successfully adopted. Management support —a factor that has been consistently found to be key in explaining adoption (Jeyaraj et al., 2006)— cannot be leveraged and behaviours must be contracted or bargained for, with parties performing an assessment of costs and benefits involved ahead of their decision making. It is precisely in these industry-wide settings that the interplay of goals and incentives takes centre stage.

While other analysis exist that look at internal incentives — whether short or long-term rewards — insufficient attention appears to have been given to how some organisations prompt other firms to innovate; that is, for an organisation to adopt an innovation chosen and promoted by another. This paper intends to contribute to the discussion on introduction of an innovation across multiple players in an industry, for which we draw on institutional theory, and to understand how adoption is affected by the alignment in strategies of the parties involved. We do this by reviewing one industry and an innovation in particular: the case of using new distribution capability (NDC) to sell passenger air travel. NDC is a standard introduced within the airline industry in 2012 to facilitate the exchange of travel service-related information between travel agents (the sellers) and airlines (the service providers) (Pietreanu, 2019). As an innovation, NDC enables the transfer of additional and richer information about travel services between sellers and service providers so that the former can present its customers with a wider and deeper portfolio of service options, potentially improving profitability (Westermann, 2013; Boin et al., 2019). However, for such a networked innovation to prosper there needs to be cooperation between many stakeholders. Teece (1992) noted that, for new product and new process development innovation to happen successfully, there needs to be both horizontal and vertical cooperation. His work argues that, in high technology, competition-intense environments, this cooperation is even more necessary and takes more complex shapes. We believe that the innovation affecting the distribution of air travel services presents such characteristics and propose that some concepts from the institutional theory (coercive and mimetic pressures) and from agency theory (information asymmetry and opportunistic

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behaviours) can help us address a scenario for innovation that has been insufficiently researched.

The aim of this study is to review the state of adoption of NDC in the airline industry years into its introduction by studying its effects on the sales of travel services as reported to the BSP (billing settlement plan), a system of local clearing houses operated by the International Air Travel Association where the majority of travel-agent-mediated passenger travel sales are settled. Through the analysis of the sales of air travel at the ticket level during 2022 in three leading markets in the adoption of NDC (Germany, France, and Greece), we posit that the use of NDC should increase revenue per ticket based on further control by the service provider over the offering (Westermann, 2013; Hoyles, 2015) and the ability to convey additional service options to the customer, which can be personalised as per passengers' willingness to pay (Wittman & Belobaba, 2017). Topolšek et al. (2014) reviewed the integration between travel service providers and their intermediaries after citing lack of academic attention in this space and found cooperation to be dependent on travel agent size and contingent on the cost effectiveness of such cooperation. Then, Bremner & Eisenhardt (2022) reviewed the case of innovation results in the drone industry when a community of users was behind it and found that, in new or evolving markets, the lack of coordination between members was a disadvantage when problems were complex and uncertainty high. In this context, our research questions are: What are the most relevant stimuli for agents to use NDC? And does NDC, as an innovation, generate higher revenues for airlines? We find that such an augmented unit revenue appears in a very modest amount and its effects could be fleeting and unstable. In fact, under some of the models we use, they revert when some predictors related to the organisation adoption stage are controlled for. We believe these results suggest that different selling patterns and behaviours are emerging across the alternative distribution methods based on the players involved, the governance mechanisms deployed for their relations, and particularly the way each of them processes incentives against their competitive strategies. Those behaviours point to diverging interests developing in sellers over those of their principals (the carriers). Although the industry-specific nature of NDC as an innovation should give us pause about potential generalisations, these findings provide for an interesting discussion about how an industry-wide innovation path to adoption can be affected by factors that transcend the boundaries of a single organisation.

The remainder of this paper is organised as follows. Section two describes the theoretical background related to the topic. Sections three and four describe the material and methods and results, respectively. Section five discusses the work and presents the strengths, limitations, and future research directions, and section six concludes the paper.

Theoretical background

Interorganisational adoption of technology innovations

So much has been said about innovation in the literature that it is difficult to single out one theory of innovation, much less an all-encompassing one, that answers our questions. Instead, we should start by describing the conditions of our interest as we determine which theories are most relevant and helpful to our case (Wolfe, 1994). For this work, we focused our attention on the way a technology innovation is adopted by an organisation when it is prompted to do so by another organisation. While studies on the diffusion of innovations (Rogers, 1995) and on the acceptance and use of technology (Venkatesh et al., 2003) have contributed greatly to our understanding of attributes of innovations in the adoption process, they are somewhat lacking in terms of addressing the interorganisational context in which some innovations must develop (Petti et al., 2024). Whenever the innovation appears as a technology linking multiple firms, some of the motivating factors behind its diffusion emerge from the conflation of behaviours, interests and goals of the many players involved. This gap can be filled through an institutional approach that offers insights on a firm's search of legitimacy, conformity to partners, and institutions' demands (Deephouse, 1996; Teo et al., 2003; Mandrinos & Lim, 2023) as drivers for innovation. This setting is further completed by the recognition of the diverging, sometimes adversarial interests between distributors and their service providing principals, and the effects that risk aversion, asymmetric information, and claims to outcomes (Sappington, 1991) have on behaviours.

Air travel is an information-intensive service industry that relies intensely on specialised technology (Sismanidou et al., 2009; Raymond & Bergeron, 1997), some of which is provided by intermediaries such as Global Distribution Systems (GDS). Farhoomand (2000, p. 6) analysed how GDS came to occupy their place as privileged intermediaries: "*After deregulation, the number of carrier choices, fare classes, and routing alternatives were beyond passengers' comprehension. Their reliance on travel agents' knowledge and expertise grew. At the same time, airlines needed to achieve operational efficiency to compete in a free market. It was under these circumstances that the CRS came to prominence*". The CRS (Central Reservation Systems, predecessor of the GDS) addressed the need to automate the reservation and ticketing process and information flows.

Airlines pay GDS booking fees for distributing its offering to a network of travel agencies. In return, the GDS pays incentives to these agencies for achieving the sales volume it uses to justify its fees to the airline, while also charging travel agents for the use of its technology. Also, airlines pay commissions to travel agencies for the sales activity that fills their planes, even though commissions have been greatly reduced since the advent of the Internet (Alamdari, 2002). Finally, consumers gain access to transportation options through travel agencies and pay fees for services that reward the entire value chain. Over time, these relationships have created an important network of interests that can give rise to entrenched positions and justify resistance to changes that endanger those interests.

Following the path of low-cost carriers, airlines have been tackling the costs of distribution under a transaction-cost-driven, vertical integration (Williamson, 1998), leveraging their own distribution channels, which have been enabled by the developments in e-commerce and Internet technologies. However, the exhaustion of that process and unrelenting competitive pressure demand that optimisation is also sought in the indirect channels, seeking both revenues and efficiency. The NDC standard comes as an innovation that addresses these issues (Alamdari & Mason, 2006), allowing airlines to create offers for travel agencies without having to go through the GDS system. NDC provides the ability to generate the offer dynamically, allowing for greater customisation and eliminating rigidities in communication messages. Wittman & Belobaba (2017a) found that dynamically adjusting for consumer willingness to pay could lead to higher incomes. In fact, airlines have recently started to introduce dynamic pricing not only in the development of their regular fares, but also in their ancillary service offerings (Mumbower et al., 2023). NDC-adopting airlines could finally retail their services as freely and efficiently through intermediaries as they do when selling directly, even if some authors found that such personalisation was lacking (Azzolina et al., 2021).

Adoption of innovations

Iacovou et al.'s (1995) parsimonious model of adoption of a technology innovation promotes three factors: perceived benefits of the innovation, organisational readiness, and external pressures in the organisational environment. The perceived benefits of NDC come as airlines market services more effectively and do not need specialised intermediaries to have their offering conveyed to the selling point

(Pietreanu, 2019). Organisational readiness takes a resource-based view and points to technological and capability endowment in the firm that is compatible and conducive to innovation adoption. It is worth noting that, for a travel agent to adopt NDC at its most basic level, a moderate investment is needed, as airlines using NDC have created web applications through which tickets can be issued. However, many of the benefits of this innovation will not be reaped by agents unless there is a more complex integration with their e-commerce systems, transforming the sales process to convey the full depth of the airline's offering. It is this combination of service offering and its integration with operations and other administrative systems that has the most significant impact on the company's results. NDC is a networked innovation that has not been developed cooperatively, but instead comes from the top of the value chain with the intention of flowing down from there. Therefore, the challenge of this innovation's diffusion and impact lies in the fact that it arises primarily as a mandate from one side (carrier) to another (agent). This response from one organisation to the behaviour of another introduces an institutional element, one that Iacovou et al. captured as external pressure. This pressure appears as a differentiation strategy in the face of competition (Song & Wen, 2023), but also as organisational isomorphism seeking the legitimacy and social endorsement attached to innovators (Deephouse, 1996; DiMaggio & Powell, 1983). Institutional theory explores how social choices are shaped, mediated, and channelled by the institutional environment (Pinto, 2017). Institutional theory suggests that because firms and other organizations inevitably pursue their interests and objectives within social contexts, they tend to conform to the rules, expectations, and beliefs expressed by their environment (Meyer & Rowan, 1977). A core principle of the institutional perspective is that organizations sharing the same environment will adopt similar practices, becoming 'isomorphic' and thereby attaining legitimacy, positive social evaluations and success (DiMaggio & Powell, 1983). Three types of pressures are identified that reinforce isomorphism (DiMaggio & Powell, 1983; Scott, 1987). First, coercive pressures result from pressures exerted by more powerful organizations; second, mimetic pressures arise when organizations respond to uncertainty by adopting the practices and organizational patterns of other successful organizations and third, normative pressures stem from organizations' tendency to adopt practices deemed appropriate in their environment.

Based on all of the above considerations, Fig. 1 shows the final model that we have used in this study.

Within the literature review, external pressure was identified as the most significant predictor associated with the adoption of an IT innovation (Jeyaraj et al., 2006). External pressure refers to influences from the organisational environment (Iacovou et al., 1995), where its two manifestations are (1) competitive pressure and (2) imposition by trading partners (with greater impact). Their analysis, predicated on the adoption of Electronic Data Interchange, can be related in several ways to the adoption of NDC given that they are both network innovations that are supposed to drive transaction costs down and facilitate process improvements. Here, airlines are prompting the travel agents (sellers) to adopt the innovation. Teo et al. (2003) studied the case of EDI adoption amongst financial institutions and found that normative pressures, followed by coercive ones and then by mimetic ones, all significantly explained decision to adopt the innovation. Ali et al. (2022) did not find significant effects of external factors, but their analysis focused on aspects related to information intensity and business requirements and not on pressure from business partners. Mahdaly & Adeinat (2022) studied the case of RFID adoption and found that trading partners' pressure was a significant determinant of adoption. However, Tiwari et al. (2023) found that pressure by a trading partner was not statistically associated with adoption for the case of electronic invoicing adoption by firms in India. Shaharuddin et al. also reviewed environmental factors and found that competitive pressure was positively influencing the uptake of electronic commerce among Malaysian travel agents. We posit that this environmental pressure is disproportionately relevant in interorganisational innovations.

Hypothesis 1. Institutional factors of external pressure exert great effect in adopting interorganisational, networked innovations.

Agent–principal misalignment

Pressure coming from the environment can appear as positive or negative incentives. The latter —penalties or distribution surcharges, which many airlines levy whenever the ticket is issued without NDC (Vellapalath, 2018; Azzolina et al., 2021, p.10)— were found to be less impactful than incentives in promoting innovating behaviours, especially where uncertainty is high (Petti et al., 2024). Carriers possess key assets in travel markets that put them in a position of power before other players in the value chain and they can leverage that imbalance to set conditions for doing business (Ford et al., 2012). Why do airlines resort to penalties to get travel agents to adopt NDC? Shouldn't all parties be agreeing that conveying a richer offer to passengers is beneficial across the entire value chain? Bingemer (2018, p. 211) provided a compelling description of the diverging interests around the distribution of services: "*Airlines usually offer ancillary services first on their own airline websites as they have full control of the*

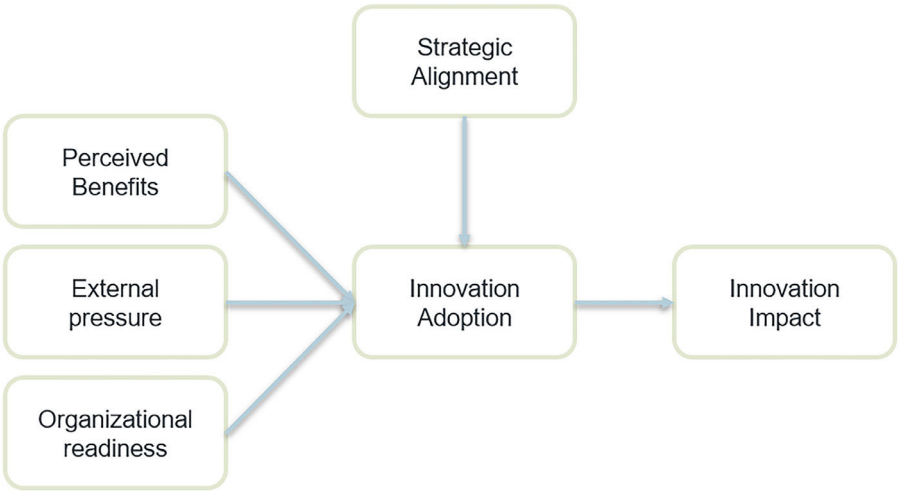

Fig. 1. Model of innovation effects for networked innovations

offer in this channel. In consequence, they do not harmonise these ancillary services (as they are meant to differentiate) with other airlines. The GDS providers, in contrast, are seeking to make the different airline offers as comparable as possible in order to reduce the search complexity for the travel agents. Thus, they have a natural interest to support only the development of those ancillary services that are implemented by multiple carriers hosted in their systems. For the case of ancillary services, it is obvious that there is a conflict of interest between being as much differentiated as possible (airline need) and standardizing as much as possible (GDS need)". Mumbower et al., (2023) also reported resistance from airlines in the US to increased transparency on ancillary prices within the GDS displays. So, there is a divergent interest in an airline wanting to offer its services above those of the competition at the lowest possible distribution cost and a seller looking to offer as wide a portfolio of services as possible with little regard for the supplier except for its preference going to those that net the highest margin. The effects of this disparity may affect the lifecycle of this innovation.

Travel agencies' activity as intermediaries also frequently goes beyond the mere selling of air transportation. For one, they provide advisory services and assistance with travel needs, such as visa arrangements or immigration clearances (Camilleri, 2018, p. 21). They also play an active role in determining the offering available in a market (Bilotkach et al., 2013) and building bundles that encompass more than air travel. This knowledge of their customers and their needs cannot be easily accessed by the airline, which operates on partial information about the requested service package and its components beyond its own offer. In such a setting, organisational theory favours outcome-based control (Eisenhardt, 1985) such as the distribution charges quickly spreading among emerging NDC carriers' marketing strategies. However, focusing strictly on the choice of distribution method attached to the travel service sale as a control mechanism can have unintended consequences, such as missing out on the value of the service sold – as we shall see. After all, the airlines' strategy of doing away with commissions and asking travel agents to collect service fees for their activities kickstarted divergence of agendas (Alamdari, 2002). Finally, the agent has another principal in the GDS that also rewards it based on the volume of reservations made through its system (Ravich, 2004). These payments operate as a disincentive to the specific behaviour of adopting the NDC innovation in that NDC distributed tickets do not count towards the incentive scheme the agent has with the GDS. Airlines then secure the agent's cooperation by applying penalties for sales processed via a GDS (under the justification that the agent should bear the cost the GDS levies on the carrier for failing to employ the cost-free alternative) (Boehmer, 2023). These surcharges often come in the form of a fixed cost per segment or ticket booked. When faced with the choice of a distribution through NDC or GDS, travel agents will likely choose the best financial option; that is, the one that allows them to obtain a greater surplus once the commissions, incentives, and surcharges are considered.

In our view, the adoption and effectiveness of networked innovations lies in the strategic alignment of the players within the value chain. For this reason and following Petti et al. (2024) we posit that incentive outweigh penalties in the diffusion of a networked innovation by increasing alignment.

Hypothesis 2. The impact of incentives on adoption is larger than that of penalties.

Impact on firm performance

Swanson & Ramiller (2004) warned that organisations innovate mindfully when they carefully consider *available rationales* and their fit to the circumstances of the firm. Travel agents would be innovating mindfully by separating the benefits NDC brings (exclusively) to airlines from industry-wide ones and from those accruing to them based on their distinct position in the air transport value chain. Xin and Choudhary (2019) reflected on the fact that organisations are unlikely to invest in IT innovations unless they are confident they will reap the rewards. In the absence of financial rewards, travel agents would see little upside in reorganising their selling processes. Travel agents are already offering a service package to their customers that frequently transcends air transportation (Buhalis, 2004, p. 808) so there is risk of crowding out their current business with airlines' new, NDC delivered services. Also, Jäckel and Maier (2016) warned of the complexity involved in adopting an innovation that requires coordinated and joint investments across the many stakeholders for it to yield maximum results.

Nonetheless, abundant literature has found that innovations improve organisational performance. Jiménez-Jiménez and Sanz-Valle (2011) reviewed a host of extant confirmatory studies and performed a cross-sectional study on Spanish firms and found that innovation makes a significant, positive contribution to business performance. Kannebley et al. (2010) provided a longitudinal analysis on Brazilian companies and equally assessed that innovative firms outperform their non-innovative counterparts, particularly for process-related innovations and mainly on the firm's net revenue. On this basis, we argue that NDC —a process innovation itself— will produce a positive impact on performance as well.

Hypothesis 3. NDC will be associated with a higher revenue (per ticket sold).

Methodology

Data

For this analysis, we have used anonymised data from the International Air Transport Association's (IATA) BSP (Billing & Settlement Plan) clearance system. This data includes details of tickets cleared between travel agents and carriers that voluntarily join and use the system to settle sales of passenger transportation services amongst the parties. IATA's BSP enjoys a majority market share among indirect sales (that is, sales not conducted directly between the carrier and the passenger) and can therefore be considered representative of the distribution of air travel services using an intermediary, the space where NDC as an innovation was introduced. The BSP data allow for observations at the service level, which in turn permits analysis on specific prices paid for transportation across different buyers.

The data used for the analysis correspond to sales of air travel cleared in the BSP during 2022 in Germany, France and Greece, markets that have been observed to have a head start in adoption of NDC as an innovation. Several conditions were added to the data set before it was used in the model. First, to isolate the issue of adoption (that is, whether the travel agent had developed some means and/or capabilities to issue tickets using the innovation), we only considered travel agents that had logged at least one ticket using NDC as the distribution method during the period reviewed. The reason for this was to ensure that all agents in the data set have proven the ability to employ the innovation and cleared initial barriers of entry. Naturally, the ability to conduct sales does not mean a complete integration of the technology into the back-office processes in the seller, which is what should optimise the results and the benefits accrued by the innovator; nor does it guarantee internal buy-in that accompanies successful innovations (Iacovou et al., 1995; Swanson & Ramiller, 2004). The other restriction introduced was, following the approach in other studies, to consider only the first leg of tickets without stopover (Narangajavana et al., 2014). This was done to ensure comparability and remove effects from interlining (still at the infancy stage under NDC) and other complexities derived from the articulation of travel services through the combination and addition of different segments, which themselves can introduce effects on the fare results

(Dorinson & Belobaba, 2004). To eliminate any effects of frequent flyer programmes, all records with zero fare amounts were deleted due to the suspicion that they could be tickets purchased with miles (Gerardi & Shapiro, 2009). Finally, only business class tickets were used: a preliminary analysis shows bias in the mix of cabin fares that comes with the use of NDC. There is a substantial higher weight of business cabin among GDS sales than in NDC sales conducted without the use of the GDS (business-class fares were four times more frequent in GDS distribution than in NDC). This effect alone is sufficient to explain a substantially higher average revenue per ticket in GDS-distributed tickets before any other predictors are accounted for. For this reason, only business-class tickets were considered. Once all considerations are accounted for, the data set used included 532,609 observations.

Model for adoption

We employed a logistic regression to model for the classification of tickets to control for adoption of NDC. Our first statistical model looks to predict the odds of any given ticket being distributed using NDC to explain the role variables play in the choice of distribution method. Logistic regression generates results within a range of 0 and 1 fitting the needs of a probabilistic analysis (James et al., 2013, p. 144). Mahdaly and Adeinat (2022) proposed the use of logistic regression to model adoption for the case of RFID adoption in the Saudi logistic services industry and found it to have sufficient discriminating power, while Tiwari et al. (2023) used it in their model of adoption on electronic invoicing. Our probabilistic model for use of NDC looks like this:

$$P(NDC) = e^{(b_1)\ COMM + (b_2)EMD + (b_3)\ PCTNDC + (b_4)SEGMNT + (b_5)\ HHI + (b_6)RTESHR + (b_7)CHARGE + (b_8)GDSSHR}$$

The first controlling variable is commissions (COMM), which are amounts paid by carriers without considering the overrides. For this analysis we have obtained the commissions paid per unit of distance and normalised to a 0 to 1 range.

Next, we consider EMD (electronic miscellaneous ticket), which are the documents that convey ancillary services sold along with the basic transportation service. For this analysis we used a dummy variable that notes whether the ticket was issued with a complementary document as a signal that ancillary services were sold along with the ticket. Although EMDs are quite a flexible vehicle to include different concepts, we have excluded all cases where the EMD was used to convey a penalty to the passenger. The economic value of the final transportation bundle is set as the dependent variable and accounted for in the regression we describe later in this paper.

The percentage of tickets sold using the innovation (that is, sold with the NDC standard) is the control PCTNDC. This variable is related to present adoption (that is, the extent to which agents are using the innovation). We factor both the percentage of tickets with the innovation for travel agents (NDCAG) and for airlines (NDCAL), as two separate variables.

Since the travel agents' value as intermediaries is essentially determined by their ability to reach some segments of the market that the airline has difficulty reaching by itself (Chircu et al., 2001), it seems appropriate to consider the specialisation or nature of the travel agent. For this reason, the model incorporates some dummy variables to describe the type of travel agent selling, with three different groups: online travel agents (OTA), which typically focus on younger travellers with a high weight of leisure destinations; travel management companies (TMC), which mostly work around business transportation needs; and, finally, every other travel agent is placed into a third category.

We derive the share of market of the carrier through the estimation of the Herfindahl index (HHI), an indicator that is frequently employed in airline pricing literature and can be seen as a measure of the ability of a carrier to drive sellers. Concentration is also associated with pricing power, and there are diverging analyses on the impact of market concentration on prices. Somewhat counter-intuitively, Borenstein and Rose (1994) found the concentration to be inversely correlated with price dispersion, which the authors attributed to the results of more sophisticated yield management allowing a better price discrimination (the dominant carriers would be able to capture higher-end consumers and maximise profits). Gerardi and Shapiro (2009) obtained opposite results using a longitudinal approach, in line with a more classical interpretation of competition reducing dispersion. More recently, Howell and Grifell-Tatjé (2022) claimed to be able to reconcile both views by factoring the heterogeneity of the product in each route. Following the above authors and Bilotkach and Pejcinovska (2011), we computed the Herfindahl index for the carriers included in our observations as a controlling variable on prices.

We also factor the share of the carrier within the route, RTESHR. While we do not account for carriers that do not report sales in the IATA BSP, this dimension can be thought of as a proxy for the carrier's market power in each route.

We have considered the distribution surcharges (CHARGE) levied by carriers from the travel agents as the last independent variable within the external pressure group. There is significant noise around these charges as airlines include them under a generic codification for airlines and so-called fuel surcharges, so it is not possible to tell when the carrier is in fact collecting other things. While the revenue variable that we use as dependent variable is net of these charges, it is expected that there will be some correlation between variables since some of these fees are built as a function of the service cost. All charge variables here have been expressed on a per km basis and normalised to a 0 to 1 range.

The share of sales within the GDS system, GDSSHR, is calculated as the percentage of tickets within a GDS a given travel agent has recorded, and we take this as a measure of alignment. GDS provides incentives to travel agents based on their sales, so the share of sales that a given selling point has within a GDS can be considered a measure of misalignment between the carrier and the travel agent. Duliba et al., (2001) investigated locations with a given reservation system to predict airline market share and found that variable to be the second most explicative (after number of departures). By observing the value of that agent to its other principal we get a measure of alignment between carrier and travel agent. Alignment and operational performance are hardly strangers. Aslam et al. (2021) reviewed the effects of blockchain in the oil industry in Pakistan and found that a close relationship with suppliers was the dimension that had the strongest and most significant impact on performance, followed by a close relationship with customers.

Further description of the variables is provided in the appendix. Using our adapted model for adoption and effects of innovation we can ascribe the above controls to the following categories: perceived benefits (COMM, EMD), organisational readiness (NDCAG, NDCAL, SGMNT), external pressure (HHI, CHARGE, RTESHR), and alignment (GDSSHR). Table 1 captures the main statistical descriptors of the data used.

A correlation matrix on the variables is provided in Table 2. Variables adding to the final ticket cost were reviewed for endogeneity as the charges themselves could be a function of the base fare applied. Correlation indices do not show abnormal values that would suggest the regression results are not valid. We also estimated VIF (variance inflation factor) and confirmed absence of collinearity (James et al., 2013, p. 112), with values consistently under five.

Model for organisational performance

We employed a linear multivariate regression to estimate the impact of NDC in the airline financial performance; that is, to explain the revenues obtained by the carrier on a given ticket so we can

Table 1
Statistical description of the variables

	NDC	share	commission	Distance	Total Rev.	HHI	Rte. Share	Days to Fly	Charge Km
Number of Values	530,277	530,277	530,277	530,277	530,277	530,277	530,277	530,277	530,277
Null values	-	155,010	450,071	-	-	10,014	-	50,445	82,406
min	0	0	0	18	-476	0.0	0.0	0.0	-0.5
max	1	1	676.12	17,039	60,713	0.2	1.0	351.0	6.4
range	1	1	676.12	17,021	61,189	0.2	1.0	351.0	6.9
median	0	0.03	0	1,218	440	0.0	0.9	14.0	0.0
mean	0.089	0.245	2.114	2,363	1,020	0.0	0.8	33.1	0.0
SE. mean	0.00	0.00	0.01	4	2	0.0	0.0	0.1	0.0
var	0.08	0.14	107.05	7,439,555	2,369,563	0.0	0.1	2315.0	0.0
std. dev	0.28	0.38	10.35	2,728	1,539	0.1	0.3	48.1	0.1
coef. var	0.26	1.55	4.89	1	2	1.6	0.4	1.5	1.6

Table 2
Correlation among key variables

	TMC	OTA	NDCF	EMD	GDSSHR	HHI	RTESHR	CHARGE	COMM	RevKm	NDCAG	NDCAL	DAYS	DIST	INTL
TMC	1.0														
OTA	−0.363	1.0													
NDCF	−0.060	0.012	1.0												
EMD	−0.054	0.138	0.017	1.0											
GDSSHR	−0.282	0.831	0.024	0.156	1.0										
HHI	0.271	−0.263	0.082	−0.004	−0.301	1.0									
RTESHR	0.003	0.076	−0.052	0.049	0.116	0.241	1.0								
CHARGE	0.007	−0.053	0.006	−0.043	−0.078	0.068	0.055	1.0							
COMM	0.043	−0.063	0.195	−0.019	−0.046	−0.110	−0.102	0.083	1.0						
RevKm	0.143	−0.221	0.084	−0.043	−0.241	0.244	0.000	0.710	0.298	1.0					
NDCAG	−0.252	0.310	0.412	0.058	0.364	−0.229	−0.041	−0.057	0.131	−0.102	1.0				
NDCAL	0.112	−0.205	0.584	−0.042	−0.207	0.204	−0.090	0.082	0.298	0.240	0.228	1.0			
DAYS	−0.144	0.065	−0.024	0.041	0.069	−0.098	−0.020	−0.037	−0.058	−0.133	0.063	−0.101	1.0		
DIST	0.064	−0.186	−0.102	−0.016	−0.203	0.099	−0.055	−0.100	−0.094	−0.120	−0.147	−0.067	0.184	1.0	
INTL	−0.189	0.122	−0.162	0.023	0.123	−0.416	−0.053	0.004	−0.159	−0.225	0.003	−0.331	0.174	0.310	1.0

assess the specific effect of NDC as the distribution choice on it. Multivariate lineal regression model is an approach that has been used for ticket price behaviour analysis by several authors (Mumbower et al., 2014; Bilotkach & Pejcinovska, 2011). We work with the revenue per km net of any charges and fees as the dependent variable, and therefore use the price per ticket sold (a financial dimension) as a measure of impact of NDC (the innovation).

The model has the following form:

$$f(x) = a_1 + (b_1)COMM + (b_2)EMD + (b_3)PCTNDC + (b_5)SEGMNT + (b_6)HHI + (b_7)RTESHR + (b_8)\ CHARGE + (b_9)GDSSHR + (b_{10})NDCF + (b_{11})WEEKMONTH + (b_{12})DAYS + (b_{13})DIST + (b_{14})INTL$$

The dimensions employed in the regression are the same as those that we used in the logistic regression, along with some others known to be present in the airline revenue management systems, which we describe next.

We have introduced dummy variables for weekdays and for the month of departure (WEEK MONTH) the flight has. The anticipation for the purchase ahead of the flight date is the variable DAYS. It is a common element in revenue management to segment the market via different inventories that increase in price as the time of departure approaches. Along with the day of the week on which the flight occurs, they have been found to be significant in price determination (Mumbower et al., 2014; Koenigsberg et al., 2008) and to be discriminant about the type of customer segment/purpose of flight and to be positively correlated with price, with business/corporate travel being skewed towards shorter notice and stays that do not include weekends (it is worth reiterating that our data set only considers business-fare-class tickets, although this does not mean that the flight is necessarily for business purposes).

Total trip distance (DIST) is another variable predicting final revenue (Brueckner et al., 2013). Here we have normalised distances to a range between 0 and 1. Whilst longer trips do come at a higher cost for the passenger, the marginal revenue per additional unit of distance is a diminishing one. Along with the distance, we have used a dummy variable that flags when the route is international (that is, to a destination outside the country), INTL.

Importantly, we now include the choice of distribution —NDCF, a binary variable describing whether the ticket was issued using NDC or not, which was our dependent variable in the adoption model— as a variable explaining observed prices, so we can study the effects of the innovation on financial results.

Results

NDC adoption model estimation

Since all our variables have been normalised to ranges between 0 and 1, the results allow us to comparatively review the independent variables by looking at the relative sizes of their coefficients. The adoption model based on the logistic regression showed that commissions paid by airlines was the independent variable that had the greatest impact on the odds of a transaction (travel service sale) occurring under NDC. The percentage of transactions under NDC (which we have indicated as a measure of the readiness and degree of adoption of the innovation by the carrier) comes a distant second after the commissions effect but suggests that (technological) readiness is a relevant factor. The surcharge structure (that is, penalty for not using the innovation) and the market power of the carrier are also statistically significant and relevant, suggesting that institutional

Table 3
NDC classification logistic model coefficients

Independent Variables	Logistic regression	Log. Regression w combined utilization
TMC	-0.468780744***	-0.4108781***
	(0.02297759)	(0.02360588)
OTA	0.147124295***	0.28592617***
	(0.0338049)	(0.03602893)
GDSSHR	2.272817086***	1.90895978***
	(0.04228743)	(0.04448348)
HHI	2.820960316***	2.45203637***
	(0.02479877)	(0.02517513)
CHARGE	-3.463312597***	-3.72195296***
	(0.1042646)	(0.10996386)
COMM	73.945899938***	69.07785439***
	(2.05501775)	(1.93873083)
EMD	0.231708241***	0.26735666***
	(0.02661537)	(0.02627165)
NDCAL	18.81923533***	12.15557411***
	(0.09805977)	(0.1692055)
NDCAG	11.756058209***	6.20779316***
	(0.0749929)	(0.13701939)
RTESHR	0.001038124	-0.04358914
	(0.03184458)	(0.03234165)
NDCAL * NDCAG		39.39349452***
		(0.84957)
Model Fit		
McFadden's Pseudo R2	0.5882469	0.5957534
AIC (Akaike Information Criterion)	130,959	128,574

Note: standard errors of the coefficients in parenthesis
Significance levels: '***' = p < 0.001, '**' = p < 0.01, '*' = p < 0.05

elements do have effects on the travel agent's behaviours, confirming our first hypothesis that, in the case of interorganisational innovations, institutional pressures (coercive, and mimetic, and normative) exert relevant effects on the firms' behaviours. It is important to remember that NDC is still in its infancy, adoption-wise, so NDC transactions are more likely than not to not happen in the first place.

Performing McFadden's R^2 calculation, which allows for an estimate of the model fit in the case of logistic regressions, we obtain results consistent with a solid explaining power for the model (Table 3). Using AIC ——Akaike Information Criterion, a statistic that helps find the best model by considering both residual error minimisation and variance explanation maximisation (James et al., 2013)—— on both models, we see that the model with the combined adoption (that is, factoring the interaction of NDC both by airline and agent) variable improves fit. We fit other models with less variables, removing those with the lower coefficients in a backward stepwise selection, and discarded them based on worse AIC scores; we have not included them in this analysis for brevity. A Chi-square test on normality of residuals was positive. Table 3 and Fig. 2 include the coefficients of the model, which are significant at p<0.001 except for RTESHR, which is not significant.

The circumstance of an agent being focused on the corporate market (SEGMNT under its TMC form) reduces the odds of an NDC transaction, but the effect is moderate. As discussed above, adoption for the corporate market demands a bigger transformation of the agent's systems and processes. Conversely, for online travel agents, which are tech-friendly but leisure-oriented organisations, the odds for use of NDC improve, also by a modest but significant amount. It seems that this dimension points to a readiness element captured as well in the percentage of NDC transactions (NDCAG). The market dominance by the carrier —a proxy for trading partner pressing power and encapsulated in the HHI indicator— has a modest effect but a degree of adoption by the carrier (NDCAL, percentage of transaction with the innovation) and the travel agent (NDCAG) shows a material impact. This suggests that the investments made and changes committed by the parties —what Rogers (1995) called redefining/restructuring of the innovation adoption process— in adapting to NDC is a relevant condition.

Do incentives outweigh penalties in the decision to adopt NDC, as we posited in our second hypothesis? Our data do suggest so. Comparing the coefficients for commissions and penalties, we find the former to be materially higher. Both are significant.

To explore the question of whether synergies stem from the synchronisation of organisations, we introduced a new dimension, NDCAL * NDCAG, in a second logistic regression model. The purpose was to understand how the *combined readiness* impacts adoption. This new dimension, which takes the product of relative adoption in both intervening organisations, jumps in the ranks of predicting power with a coefficient that comes close to COMM (normalised commissions per distance travelled) and is also significant. From an institutional perspective, we can assess that the response of one organisation (the seller) to another's (the carrier), whether as a mimetic

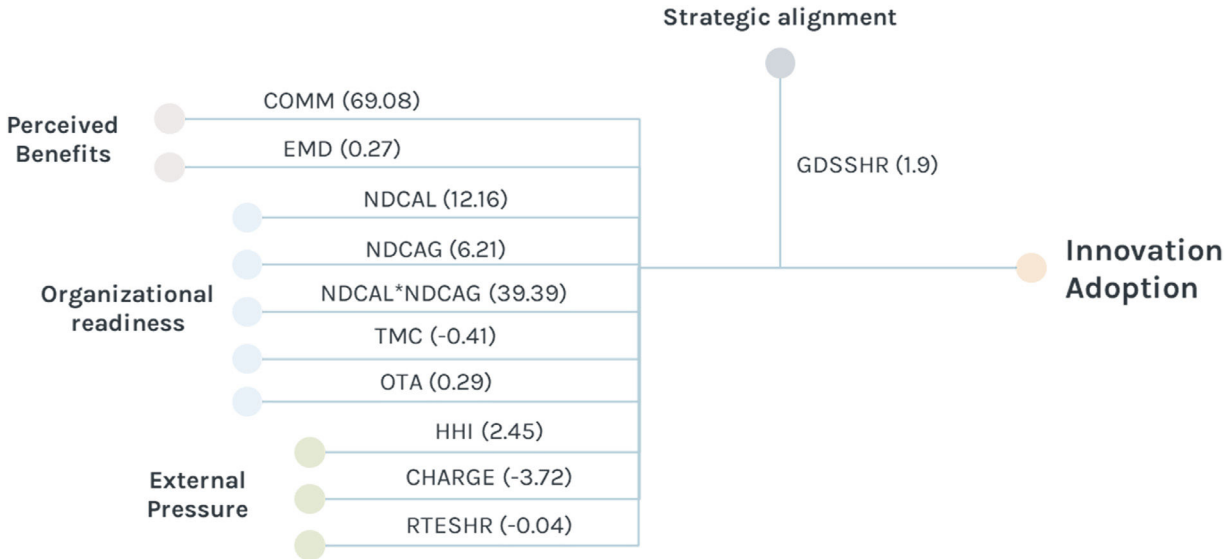

Fig. 2. Coefficients of the logistic regression

Table 4
Lineal regression estimating net revenue per unit of distance.

Independent Variables	Model with ALNDCPCT	Model without ALNDCPCT	Model with Interactions
COMM	29.683145	30.274005	29.986262
	(0.1186685) ***	(0.116632) ***	(0.119452) ***
EMD	0.0489439	0.047975	0.048998
	(0.002417) ***	(0.002418) ***	(0.002416) ***
NDCAG	-0.1408861	-0.123276	-0.13508
	(0.005383) ***	(0.005345) ***	(0.005387) ***
NDCAL	0.1176568	N/A	0.269129
	(0.0044401) ***		(0.008328) ***
TMC	0.0367373	0.03883	0.036567
	(0.0014003) ***	(0.001399) ***	(0.0014) ***
OTA	-0.0748308	-0.077194	-0.074962
	(0.0021882) ***	(0.002188) ***	(0.002187) ***
HHI	0.2569301	0.260532	0.235
	(0.0018565) ***	(0.001853) ***	(0.002118) ***
RTESHR	-0.1035083	-0.107236	-0.10533
	(0.0019893) ***	(0.001986) ***	(0.00199) ***
CHARGE	32.452457	32.559022	32.14418
	(0.0493701) ***	(0.049239) ***	(0.051391) ***
GDSSHR	-0.1036631	-0.110378	-0.101135
	(0.0026753) ***	(0.002665) ***	(0.002677) ***
NDCF	-0.0003904	0.032852	0.037549
	(0.0024956)	(0.002159) ***	(0.003056) ***
DAYS	-0.2124246	-0.21738	-0.210504
	(0.0040559) ***	(0.004054) ***	(0.004055) ***
DIST	-0.1492281	-0.145388	-0.147378
	(0.0038551) ***	(0.003855) ***	(0.003854) ***
INTL	-0.1478521	-0.157023	-0.156223
	(0.0018072) ***	(0.001775) ***	(0.001848) ***
NDC*NDCAL	N/A	N/A	-0.227289
			(0.010575) ***
Model fit			
Adjusted R^2	0.5832	0.5827	0.5836

Note: standard errors of the coefficients in parenthesis
Note 2: for brevity we do not include coefficients for the day of the week and month dummy variables. They are all smaller than 0.0723 and significant at $p < 0.001$ except dummy weekend which is at $p < 0.01$.

or coerced behaviour, appears as relevant factor in adoption. We should be cautious about causality given the cross-sectional nature of our analysis, and we touch on this on limitations of our analysis below.

Performance results

Having reviewed the factors behind adoption, we now use lineal regression models to address the impact on revenue, and the role NDC plays in it, as a measure of performance. We employed three different models here to analyse and discuss some interaction between predictors. We start with a model that does not consider interactions. Looking at the results, some of the coefficients are consistent with prior analysis on airline fares: unit revenues increase with shorter period to flight date, or when starting date falls on a weekday vs weekend (Koenigsberg et al., 2008). Concentration of market power correlates with a higher revenue but share of traffic in each route showed a small negative coefficient (this could be related to the least profitable routes attracting a smaller number of suppliers, but also could be affected by low-cost carriers, which do not typically use intermediaries for their distribution and are not considered in these estimates). The dummy variable for agent segment showed that travel management companies do correlate with higher revenues, consistent with a target customer willing to pay higher fares to avoid restrictions (for example, the need to stay over a weekend, cancellation, or modification terms) that come with the lower prices (Granados et al., 2011; Vinod & Moore, 2009). Online travel agents, which have an expected higher concentration of leisure travel, present a negative coefficient. All coefficients are found to be significant ($p < 0.001$). Model coefficients are included in Table 4.

The predictors that showed the strongest effect on unit prices (our measure of impact) were those reflecting charges and commission levels; that is, those forming the incentive scheme behind the NDC adoption and those belonging to the external pressure exerted by trading partners to the firm (Fig. 3). Considering that all values in the dataset had been normalised to ranges between 0 and 1, the size of the coefficients provides a relative measure and validates our assertions so far that in these types of network innovations institutional, value chain dimensions are of first-order importance.

Our results showed that using NDC as the distribution method (the innovation) has a weak but positive effect on distance adjusted revenue. Interestingly, if we build a second model adding the percentage of NDC tickets sold by the airline (NDCAG) as a regressor, there is a flip of the sign of the coefficient for NDC, which becomes negative, albeit almost zero. The reversal suggests the existence of some interactions amongst variables (James et al., 2013). When using a (third) model that both controls for the percentage of NDC tickets by the carrier in the period and its interaction with the use of NDC, the sign for the NDCDST dimension becomes positive again. However, the fact that the interaction of NDC adoption by the carrier and use of NDC by the travel agent appears negative implies that airlines with a higher adoption (and thus pressure to their travel agents) were not realising higher revenues per unit of distance than less advanced peers. These interactions merit some attention and, in our view, illustrate a possibly relevant business problem, which we elaborate on next.

Using a simplified model of just two variables interacting (that is, the NDCDST variable and the percentage of NDC transactions by the airline NDCAL, along with their interaction, NDC*NDCAG) shows that the tipping point on the revenue coefficient comes at an adoption rate of approximately 15 per cent; in other words, airlines with over

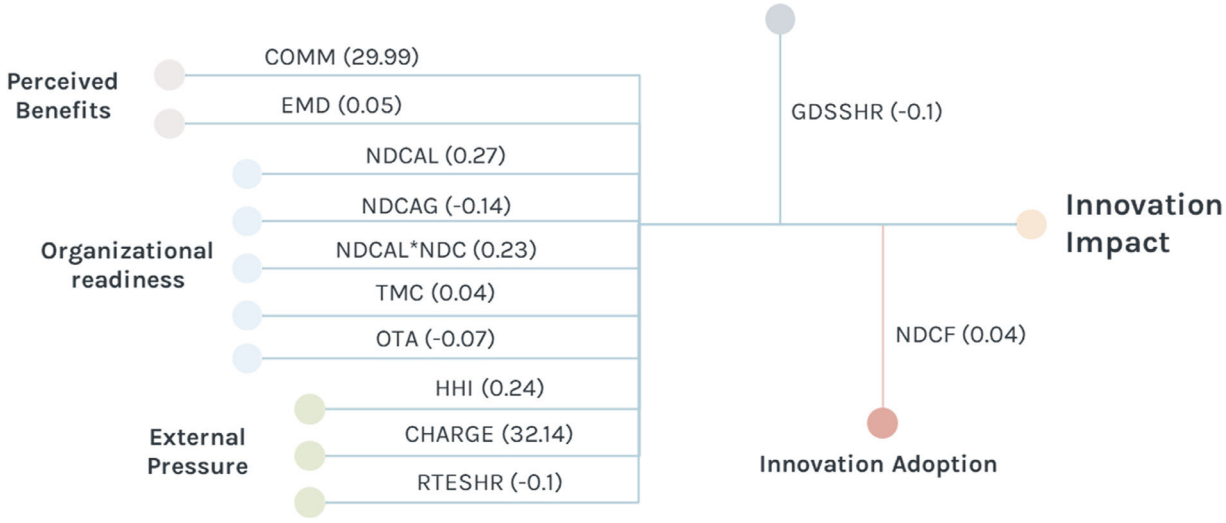

Fig. 3. Coefficients for the linear regression

15 per cent of their transactions being NDC show a negative (albeit minor) impact on their revenues per unit of distance (see Fig. 4 for a chart that plots these behaviours).

This pattern reconciles with the following theory: As airlines get more invested in their NDC plans, their distribution policies are likely to get more systematic and comprehensive, the pressure to agents reaching a tipping point that results in a reorganisation of its sales strategy that pushes lower value sales to the newer option. Some airlines have reported commercial strategies that remove some of the cheaper fares, which are the easiest to sell and quickest to stock out, from GDS to entice travel agents into adopting the innovation (Silk, 2023). In this environment, travel agents modify their own selling tactics by discriminating what they push across their different platforms. They adapt to the changing context by employing NDC to market cheaper fares, or services easier to distribute, following a profitability criterion.

After obtaining confirmation of our two first hypotheses, we then found a partial confirmation to our last hypothesis regarding NDC distribution having a positive impact on performance. Whilst these positive results can be observed in some cases, we also found that, for larger carriers, where pressure is maximum, effects on revenue per ticket evaporate. Petti et al. (2024) found that the intensity of the

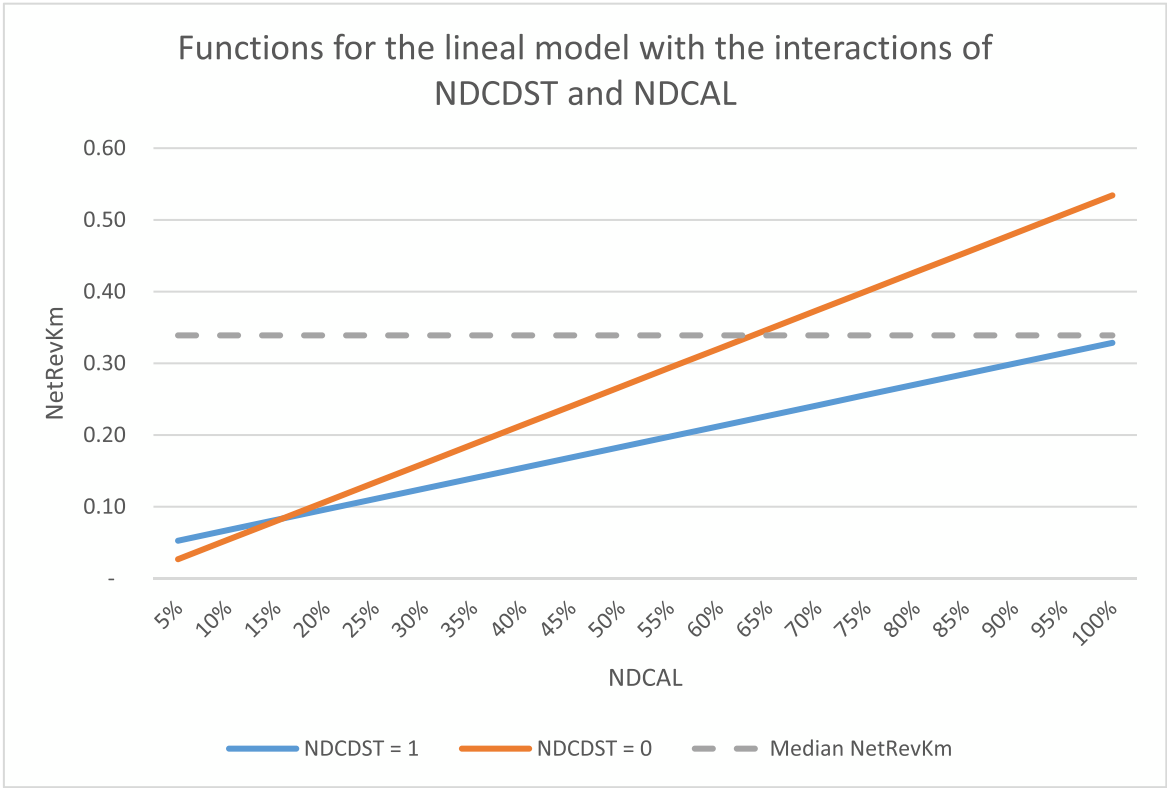

Fig. 4. Representation of revenue as a bivariate function of NDC use and NDC carrier adoption.

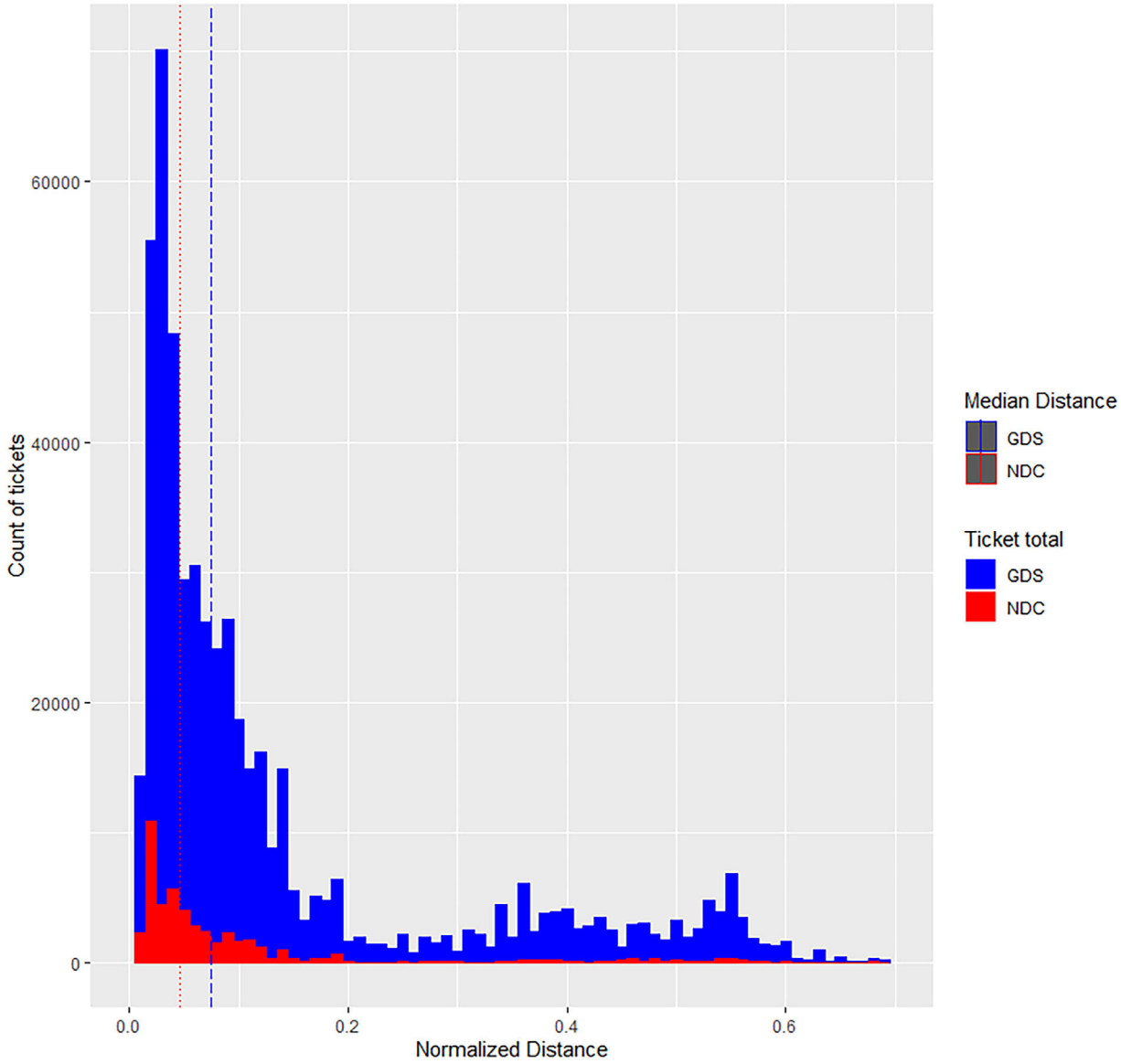

Fig. 5. Comparison of flight distances between NDC and GDS Distribution

moderation between incentives and innovation performance was higher in high-turbulence/uncertainty environments, so we can posit that travel agents perceive uncertainty decreasing as NDC adoption exceeds a tipping point, which could in turn weaken the effects of those incentives. Looking at the distribution of flight distances between NDC and GDS sales, we obtain further validation of our explanation. Rather than seeing similar patterns across both options as a neutral content distribution would suggest, NDC tickets appear to have distinctly shorter distances than their GDS-distributed siblings. Shorter, leisure routes, which are arguably easier to sell online and more sensitive to mere fare comparison, become more frequent within NDC. Fig. 5 shows the different patterns in tickets distributed through both methods.

Discussion

When innovations are introduced in the market, multiple factors need to coalesce in order to produce the expected results, and adoption by one of the players in the value chain is merely one of these factors. If the innovation relates to distributing products and/or services, then the whole value chain in an industry may need to move coordinated and every organisation may need play a role in order for its effects to be visible. An institutional approach to innovation becomes particularly adept as providing answers to this setting: external pressure by a trading partner can provide the spark for some organisations to take on an innovation, as a response to other organisations' behaviour, for coercive or mimetic reasons. Pressure can come in the form of results-based incentives such as those described in this article. In our analysis we found evidence that institutional factors play a major role in spurring behaviours around adoption of the innovation, and that positive incentives outweigh penalties explaining the adoption process.

What happens when preferences and incentives are misaligned, or if multiple principals demand opposing results? According to Shapiro (2005), the relationship between travel agents and the GDS has evolved over time: from the GDS being an IT supplier to another where the GDS resembles a second principal that can interfere in the business logic of adopting NDC. Travel agents often lack the size to access the capital and afford to develop innovation capabilities (Rajapathirana & Hui, 2018; Mahdaly & Adeinat, 2022), which can make them more reliant on the GDS.

In finding an explanation for this process of adoption and effects, it is useful to consider how NDC as an innovation gets successfully adopted by travel agents. To sell a ticket using NDC distribution, the seller needs to establish a messaging process with the airline to receive the inventory and its associated features and be able to wrap the results within its own offering. This integration is significantly more complex for some agents, such as travel management companies (TMC), which provide their customers with a host of additional features (for example, approval workflows aligned with a company's hierarchies and expense policies, as well as specific reporting and accounting data feeds), which also need to be replicated under the new data exchange mechanisms. Monteiro and Macdonald (1996) found that optimising information systems for efficiency made it more difficult for organisations to become flexible in the use of that information. TMC has optimised efficiency and therefore faces a tougher road to adapt to NDC. Therefore, NDC adoption is not uniform across all travel agent segments: TMCs lag behind other agents that have less complex operations, such as online travel agents.

Our last hypothesis regarding performance uplift from innovation was only partially confirmed: We did not see revenue improvement amongst carriers with the highest NDC readiness. In our view, agents consider not only revenue, but also factor risks, profitability and technical and organisational implications, including their relationships with other agents and suppliers, to determine their future behaviour. We have previously discussed that commissions (a positive pressure) received may have a larger effect in determining adoption, but then when it comes to impact on revenues, the pressure exerted by the carrier through distribution surcharges (penalties, or cost pass-throughs) seems to carry more weight. This combination of effects on income and on service composition —not only what to distribute, but how— resulting from travel agents evaluating the environment to determine the best strategy looks very similar to the mindful innovative organisations described by Swanson and Ramiller (2004). Given that revenue effects seem to become negative for airlines with higher NDC adoption, we posit that as airlines develop and tighten their distribution policies, the sales composition effect outweighs the increase in income. It may also be that, at this early stage, airlines are prioritising the cost benefits of disintermediating the GDS over the revenue upside, and that for travel agents, performance is measured in overall profitability, revenue assurance and not just nominal fares obtained. Airlines thus see that their agents push the lower cost, simpler, and probably less lucrative fares through the innovative channel whilst preserving the services that are more profitable —and hence withstand surcharges better— for the legacy mechanism they still know best and feel they control better.

What implications does this analysis bring? To begin with, it raises the question of whether the observed response is indeed what carriers' designers had in mind. If the simpler content shifts quickly and easily to NDC, while the business that has a higher margin but is more valuable business remains within the GDS, then airlines may be able to drive distribution costs down and rely less for load factor on legacy distribution but still depend on that distribution for the higher value customers and the profitability they bring. According to Chircu & Kauffman (2000), to effectively disintermediate organisations, the target of the disintermediation should not be able to leverage *co-specialised* assets (in this case, the relationship with corporate customers and the integration with their accounting systems).

In summary, we are seeing a classic manifestation of the principal agent theory (Waterman & Meier, 1998). Travel agents have separate incentive schemes around each distribution method, and they also know the segment and services that their customers request, information that the carrier does not fully have. So, they perform an ex-ante calculation of the financial outcomes of the transaction and opportunistically drive sales through the method that works best for them. In fact, as airlines have shifted away from intermediaries and into direct sales, travel agents have been forced to rethink their business around their customers and as processors of information and advisers (Cheng, 2023), further diverting their goals and business from that of their air travel principals. Airlines may want to adapt their policies to the travel agent case, for instance by establishing different distribution policies per cabin class, or working differently with different travel agent segments, recognising that travel management companies favour process integration over surcharge avoidance. Eisenhardt (1985) argued that principals can also control their agents through convergence of preferences; that is, when airlines and travel agents share the same goals, external pressure may be unnecessary. If airlines are going to control not just the shift of sales but also the type of offering and segment these sales go to, they need to broker some policies that unite the agents' interest with theirs. For instance, they could personalise their commissions to involve addition of ancillaries or structure their distribution surcharges to specifically apply in ways that consider the revenue potential (that is, work dynamically so that they apply for trips for which channel choice is unaffected by other service considerations like leisure heavy routes).

Limitations and Future Research

Given the size and wealth of the dataset, the results of this study can be taken to be representative of airlines and market behaviours. At the same time, we have only considered business class and only the first leg of non-stop tickets. It is conceivable that the effects observed here are not present, or appear in a different degree, when other types of services are assessed. Other limitations should be acknowledged. First, the data do not accurately capture sales of low-cost carriers (LLC). While LLC are known for minimal reliance on external distributors and thus play a small role in NDC, it is possible that their effect on market competition and fare levels is missed here. Second, the data on surcharges is noisy, as airlines report different types of surcharges under broad categories. Another important consideration has to do with the adoption stage, particularly given the observation that results are different across the level of use of the innovation. It is possible that when the technology matures and all players can adapt their internal processes, operations and technologies to it, the interplay of incentives and their effects on goals could evolve. This limitation could be addressed through a longitudinal view that observes evolution of results across a period. Finally, the airline industry is very particular in its structure, with the GDS playing a role and exerting an effect over the distribution that is not easily observed elsewhere (not even hospitality sees this level of IT-driven lock-out effect). This makes it harder to find generalisations where incentives may be different. Still, the introduction of an innovation and its adoption at the request of a dominating partner is by no means an exceptional case.

There are several questions stemming from this analysis that could be addressed by future research. What strategies are GDS deploying to adapt to this change that threatens to disintermediate them? GDS are already shifting their offering to reduce reliance on mere distribution and onto a host of technology services that keeps their relevance in retailing transportation services, so it would be appropriate to assess whether we are once again witnessing a reintermediation process (Kracht & Wang, 2010). In the past, travel intermediaries have proven to be quite resilient to this type of transformation and shown the ability to adapt to evolving market needs (Alamdari & Mason, 2006). Another area of potential research comes from the transformation of the market for travel services intermediaries as the innovation standardises the process by which an offering reaches the end customer. Will intermediaries take these changes, which can potentially erode their ability to differentiate themselves from other competitors? What value levers will remain effective at engaging travellers, and particularly, how will ancillary services come to be distributed once both the service provider and the intermediary can technically deliver them? Finally, since we have

proposed that innovation effects theory consider strategic alignment as a factor, it would be interesting to comparatively review cases of innovation adoption with different degrees of value chain conflict to measure the impact of alignment.

Conclusions

For technology-based, interorganisational innovations to succeed, they need to permeate organisations throughout a full value chain. Such is the case of NDC, an innovation that is expected to facilitate and improve the way in which travel services are conveyed and marketed by airlines to their travel agents, boosting sales and expanding business. To consider the adoption and the effects on performance, we have drawn on an institutional theory approach. We employed a model of adoption for a technology innovation that factors perceived benefits, external pressure, and organisational readiness, to which alignment between parties has been a necessary consideration. We find that institutional, mostly coercive pressures from other organisations appear to contribute to the adoption of NDC, and that incentives play a bigger role than penalties. We observe that revenues on tickets distributed under NDC barely increase for airlines. The effect is in fact negative for carriers deeper into the use of NDC.

What can be done? If multiple organisations must adopt an innovation for it to show its true effects, other elements must be considered, particularly the strategic alignment between players. We posit that travel agents are performing what appears to be a calculated, thorough process of incorporating the innovation, resulting in a selective adoption that considers their own customers' needs, their other business partners, and the innovation effects on their overall income before committing to NDC. This process is the consequence of a somewhat different agenda for retailing services to consumers between agents and carriers. Airlines seem to be on track to reap distribution cost savings; however, to see revenues grow thanks to NDC, they will need to rethink the incentives and work to ensure their strategies and that of their agents converge. Although NDC is an industry-specific innovation, it has some network characteristics that we also see in EDI transmission or RFID in the supply chain, so we can take learnings and seek some generalisations. Adoption within a single firm could leave it with locked-out resources and little gain to show. Whether the innovation utilisation ramps up and delivers to its full potential or only permeates behaviours in limited ways will depend on how players work to produce a business case that can be fit in more than a single firm's strategy.

Declaration of competing interest

Manuel Sáenz is employee at the International Air Travel Association (IATA).

CRediT authorship contribution statement

Alberto Urueña: Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Manuel Sáenz:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Antonio Hidalgo:** Writing – review & editing, Validation, Supervision, Conceptualization.

Appendix. Glossary of Variables used in the models.

Variable	Meaning / Description
COMM	Commissions paid on the ticket excluding overrides, normalized to values within 0 and 1
EMD	EMD stands for electronic miscellaneous documents and it's a dummy variable reflecting whether additional or ancillary services were sold along with the ticket
PCTNDC (NDCAL + NDCAG)	Percentage of tickets distributed using NDC (the innovation). PCTNDC summarizes the two controls included here: NDCAL, which is the percentage of NDC tickets by the airline, and NDCAG, which is the percentage tickets by the travel agent
SEGMNT (OTA + TMC)	Segmentation of the travel agent as per IATA's own statistical analysis. SEGMNT summarizes the two dummy variables for segments: OTA which comes as one if the travel agent is an online travel agent and TMC which equals one if the travel agent is a travel management company working with corporations as customers
HHI	Herfindahl index for the airline providing the service using the sales within the data set
RTESHR	This is the share of flights by the carrier within the route of the ticket
CHARGE	Distribution charges per unit of distance levied by the carrier on the flight, excluding taxes. Data has been normalized to values between 0 and 1 (for the maximum value).
GDSSHR	Share of tickets within a given distribution system by the travel agent selling the ticket. The share is calculated for tickets sold in 2021, that is, during the prior period to that in the dataset.
NDCF	Factor that indicates whether the ticket has been distributed using the NDC standard or via a GDS.
WEEKMONTHS	Dummy variables that capture the month for the departing date of travel and whether the day of the week was either Monday through Thursday, or a Friday, or Weekend (Sat, Sun).
DAYS	Normalized value between 0 and 1 for anticipation between the purchase of the travel service and the departure date.
DIST	Distance between the origin and destination. Only one trip, non-stop have been used in the analysis so distance is always the straight line between the two points.
INTL	Dummy variable that separates trips with a destination in a different country from the origin.

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