Rethinking the effect of risk aversion on the benefits of service innovations in public administration agencies

Nuttaneeya (Ann) Torugsa [a,*], Anthony Arundel [a,b]

[a] Australian Innovation Research Centre, University of Tasmania, Private Bag 108 Hobart, Tasmania 7001, Australia
[b] UNU-MERIT, Maastricht University, Boschstraat 24, 6211 AX Maastricht, The Netherlands

ABSTRACT

This study applies a holistic approach grounded in configurational theory to a sample of 2505 innovative public administration agencies in Europe to explore the effect of organizational risk aversion on the benefits from service innovations. The analyses, using fuzzy-set qualitative comparative analysis (QCA), identify several combinations of strategies (varying by the agency size and the novelty of innovation) that managers in risk-averse agencies can use to work effectively around the risks of innovating. The findings show that the managers of both high and low risk-averse agencies can achieve high benefits from their innovation efforts, but their strategizing behaviors differ. An integrated strategy that combines collaboration, complementary process and communication innovations, and an active management strategy to support innovation is the most effective method for 'low-risk-averse' small agencies and 'high-risk-averse' larger agencies to obtain high benefits from either novel or incremental service innovations. Our results point to the need to rethink the conventional assumption that a culture of risk aversion in public sector agencies is a cause of management ineffectiveness and a stumbling block to innovation success.

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1. Introduction

The past two decades have witnessed an increasing policy interest in using innovation to improve the quality and efficiency of public services and thus to produce large benefits from social welfare maximization (Arundel et al., 2015; Brown and Osborne, 2013). Yet there is a broad understanding in the economics of innovation literature that the process of innovation carries significant risks and therefore requires organizations to tolerate both risk-taking and failure (Dodgson et al., 2005). Nevertheless, the pursuit of efficiency in public services often involves the reverse, with a stress on the downside of risk and support for a culture of risk aversion (Potts, 2009; Ritchie, 2014).

In public services, an organizational culture of risk aversion is exacerbated by the vulnerability of users of public services and by the intense and relentless political and media scrutiny that such services receive (Borins, 2001; Chen and Bozeman, 2012). Other causes for a cautionary approach to risk-taking and failure include the difficulties of achieving (and measuring) innovation success (Hartley, 2005), bureaucratic norms that emphasize rules

over results and processes over outcomes (Boyne, 2002), and the asymmetric relationship between those bearing the risk involved in innovation and those garnering the reward or incentive (Albury, 2005; Ritchie, 2014). As a result, a risk-averse culture is thought to act as a major impediment to innovation in public services (Brown and Osborne, 2013; Potts, 2009). Yet this view, while widely embraced in the literature, has rarely been tested empirically. Several surveys of public managers have provided descriptive data showing that risk aversion is not a major barrier to the development of innovations (Bugge et al., 2011; Gallup Organization, 2011; UK National Audit Office (NAO), 2000), but none examined the effect of risk aversion on the benefits (or otherwise) from innovation, or took a holistic approach to understand the configurations of conditions under which risk aversion can spur or stifle innovation success.

To the best of our knowledge, this is the first study to employ a holistic contingency approach, grounded in configurational theory, to study the effect of risk aversion on the benefits from service innovations in the public sector. Using data from a large survey of the innovation activities of European public administration agencies, we explore how different levels (high/low) of risk aversion combine with other factors or strategies (i.e., organizational size, innovation novelty, innovation development method, complementary innovations, and an active management strategy to support innovation) to elicit different levels (high/low) of benefits from service innovations. The analyses are restricted to innova-

* Corresponding author.
E-mail addresses: Nuttaneeya.Torugsa@utas.edu.au (N. Torugsa),
Anthony.Arundel@utas.edu.au (A. Arundel).

tive agencies that introduced one or more "new or significantly improved services", following the definition of a service innovation in the OECD/Eurostat's (2005) Oslo Manual guidelines for measuring innovation. We focus on service innovations because they are publicly visible and consequently are more likely to attract media scrutiny and hence be affected by a culture of avoiding risk. The public visibility of services also improves the ability of respondents to determine if their innovation is novel or incremental. To capture the heterogeneity in the strategic behavior of agencies with high and low levels of risk aversion, we use fuzzy-set qualitative comparative analysis (QCA) to identify combinations of strategies that are linked to beneficial outcomes and we verify our results using multivariate regression.

The focus of this study is on organizational risk aversion, defined in the survey as the importance of a "risk averse culture in your organization" in "preventing or delaying your organization's efforts to develop or introduce [innovations]", as perceived by the respondents, who are senior managers responsible for public administration agencies. This variable assumes that risk adversity is a characteristic of the organization, such that organizations have a specific culture that is separate from the personal attitudes of senior managers (Parry and Proctor-Thomson, 2003; Wynen et al., 2014). Drawing on prior research on risk perception theory, we contend that the agency head's perception of the risk culture of their organization is a reasonably accurate assessment of attitudes within the organization (see Bozeman and Kingsley, 1998; Chen and Bozeman, 2012), and that risks are usually viewed by agency managers as manageable (Australian NAO, 2009; Slovic, 1987; UK NAO, 2000; Ventriss, 1998).

The novel contributions of this study lie in its ability to explore the conventional assumption that a risk-averse culture in public agencies is a cause of management ineffectiveness and a stumbling block to innovation success. The evidence found in this study suggests that: (1) there are several combinations of strategies that managers can deploy to effectively manage or circumvent risks, (2) these combinations are context-specific and differ between high and low risk-averse agencies and between novel and incremental innovations, and (3) the level of risk aversion is a relevant but not deterministic condition for high innovation benefits; rather, the ability of managers in risk-averse agencies to implement appropriate combinations of strategies for managing risk is what drives innovation success. Since imitating what works elsewhere is actively encouraged in public service agencies (Hartley, 2005; Torugsa and Arundel, 2016b), non-innovators that fail to successfully innovate due to risk-averse cultures could learn from the strategies used by successful innovators to manage risk and imitate them. The insights from this study thus carry significant policy and management implications.

2. Innovation in public services and organizational risk aversion

There is a growing perception that innovation can contribute to service enhancement and improved productivity in public services, leading to increased pressure on agencies to be more innovative (Borins, 2001; Hartley et al., 2013; Osborne and Brown, 2011). Service innovations in the public sector can vary from highly novel or transformative services to small-scale incremental changes (Hartley, 2005), they can encompass one type of innovation or incorporate multiple innovation types which make them more complex and difficult to implement (Torugsa and Arundel, 2016a); and they can be developed in-house or based on adapting new services that have already been implemented elsewhere (Arundel et al., 2015; Bugge and Bloch, 2016). The diffusion of service innovations to other public agencies is particularly important to

improving the quality and efficiency of services across the public sector (Hartley, 2005). However, innovation does not always result in improved benefits. For example, new public services can lead to an increase in choices that are not desired by citizens, organizational learning without benefits to future innovations, or decreased performance due to a failure to overcome mistakes, obstacles and dead-ends during innovation implementation (Hartley, 2005).

The implementation of an innovation in public services, as Hartley et al. (2013, p. 822) write, involves "a complex and iterative [but non-recursive] process through which problems are defined, new ideas are developed and combined, prototypes and pilots are designed, tested and redesigned; and new solutions are implemented, diffused, and problematized". This process inherently involves risk, but in the public sector potential losses from risk are given more weight than potential gains from an innovation, leading public servants to perceive risk as associated with negative outcomes and largely ignore the potential for positive outcomes (Ritchie, 2014). As contended by Ritchie (2014, p. 13), "the costs [risks] of an [public service] innovation are almost certainly measurable, specific and traceable to the decisions of individuals", but the benefits of the innovation are often uncertain, difficult to measure and diffused over numerous recipients. This underestimation of relative gains, combined with higher penalties for failure compared to rewards for success and with policy ambiguity that divorces rewards from performance, damages incentives to innovate and unfavorably affects risk perception (Boyne, 2002; Ritchie, 2014).

The risks of innovating in the public sector are further exacerbated by four external factors that can act to support a culture of risk aversion. First, public service innovations are exposed to high levels of public scrutiny and media attention (Albury, 2005). Since service innovations are publicly visible and frequently need to balance contested goals and outcomes (Hartley et al., 2013), they can be exposed to intense scrutiny before the full completion of what is often a lengthy implementation process (Albury, 2005; Arundel and Huber, 2013). Second, even if the service innovation is an adaptation of an idea that has been effectively used elsewhere, in a new context it may not deliver its intended benefits or fail to be accepted by its intended users, the media or politicians (Brown and Osborne, 2013). Third, many agencies produce and deliver services to vulnerable individuals, groups and communities, and consequently the risks to the wellbeing and quality of life of citizens are of great significance when experimenting with new services or ways of doing things (Albury, 2005; Brown and Osborne, 2013). The last factor is the co-existence of different, competing regimes of public sector governance (traditional public administration, New Public Management (NPM), and networked governance), with each having different rules for the role of politicians, managers and citizens and thereby having different strengths and weaknesses for how innovation occurs (for further discussion of implications of different modes of governance for innovation; see Hartley, 2005, 2016). The factors that drive an organizational culture of risk aversion are likely to vary by the governance structure of each agency, with political aversion to risk an important factor in traditional public administrations, a lack of sufficient incentives a factor for NPM, and concerns over citizen well-being a factor in networked governance. Since there can be elements of all governance regimes present at the same time in public agencies (Hartley, 2016), the different factors behind a culture of risk aversion could interact to increase or decrease risk aversion, creating differences in the level of organizational risk aversion across agencies. Unfortunately, we lack data on the governance structure for each agency.

Since government agencies are pushed and pulled in many directions simultaneously, it is hard for them to be able to balance and reconcile conflicting goals and this consequently can stiffen a culture of timidity and organizational risk aversion, creat-

ing concerns that such a culture will compel managers to avoid risk by either not innovating or by preferring incremental over transformative innovations (Brown and Osborne, 2013). However, the assumption that organizational risk aversion deters or prevents agency managers from developing service innovations may not be accurate. In our dataset, 53% of 3699 agencies reported a risk-averse culture as having high or medium importance in preventing innovations, but 71% of them introduced a service innovation. This evidence aligns with a study by the UK NAO (2000) that found that 42% of 237 agencies surveyed regarded themselves as more risk-averse than risk-taking, but 82% of them said they actively support innovation to achieve their goals. Similarly, the Australian NAO (2009) reported that highly innovative public agencies have well-established risk management frameworks based on a 'risk-aware' approach that enables managers to learn from mistakes and failures in a positive way (e.g. building on lessons learned from failures to make better decisions about their future innovations).

The positive link between innovation and organizational risk aversion can be explained through the concept of 'revealed barriers' proposed by D'Este et al. (2012) in a study of innovation in the private sector, where innovation activity increases the manager's awareness of not only the obstacles constraining innovation and the risks involved, but also the strategies that can be used to circumvent and overcome them. This concept, we believe, is very likely to apply to the public sector, especially because public managers (compared to their private counterparts) have a stronger motivation "to serve the public. . .and to promote the public interest" (Boyne, 2002, p. 102). Therefore, avoiding risk by not innovating can be perceived by public managers as more risky (based on their estimation of costs or negative outcomes). Viewed from prospect theory which postulates that people tend to regret losses more than value gains (Kahneman and Tversky, 1979), managers in risk-averse agencies, when faced with a choice between losses (instead of between gains), could display careful, risk-taking behavior by engaging in innovation and finding ways to minimize the negative effects of risk to achieve innovation benefits (Kay and Goldspink, 2012; Ritchie, 2014).

However, it is worth noting that there have been no studies to date (as far as we are aware) that have empirically examined the strategies that public managers can use to innovate within a risk-averse culture in order to maximize innovation benefits, and this shortcoming is addressed in this paper. We argue that the strategies that managers can use to innovate under different levels of risk aversion are likely to vary, due to heterogeneity in the context in which innovation occurs, the characteristics of their innovations, and the skills that they can draw upon. Consequently, there is unlikely to be one best set of strategies for achieving innovation success. What works in one circumstance or context may not work in another. Brown and Osborne (2013) call for the need for research on risk and innovation in public services to be grounded in a realistic and holistic approach. Our study responds to this call by applying configurational theory (based on the presumption of multiple contingencies) to explore how different factors are combined under different levels of risk aversion to result in high or low levels of benefits from public service innovations.

3. A configurational approach to risk-innovation engagement

Configurational theory contends that the ways for achieving an outcome (for instance innovation benefits) are dependent on configurations or combinations of different attributes (i.e., factors or strategies). The core tenets of configurational theory are recipe, equifinality, causal asymmetry, and contrarian cases (Fiss, 2007; Meyer et al., 1993; Ragin, 2000, 2008; Woodside et al., 2013). The

recipe tenet is the idea that each individual attribute on its own is not sufficient for an outcome to occur, with the need for combinations of different attributes. The equifinality tenet suggests that multiple causal paths (recipes) can lead to the same outcome. The casual asymmetry tenet stresses that the recipes leading to the presence and absence of an outcome are not mirror opposites of each other. The contrarian cases tenet suggests that an individual attribute in a recipe can contribute positively, negatively, or not at all to an outcome, depending on the presence or absence of the other attributes in the recipe. Through the lens of configurational theory, a set of strategies for innovating under a given level of risk aversion is determined by the context in which agencies operate, which in turn influences the strategies that are required to manage risk.

While theoretical research suggests that a risk-averse organizational culture is a major barrier to innovation in public services, a complication that is by no means clear from the literature is the interactions between different levels of risk aversion and other factors endogenous to the organization (Brown and Osborne, 2013). This study addresses this issue by examining the effect of a risk-averse culture plus six other factors on the beneficial effects of service innovations. We constrain the number of other factors to six because QCA limits the number of factors to reduce computational complexity and increase reliability. These six additional factors include the agency size (medium-to-large versus small), innovation novelty (novel or incremental), the method of developing service innovations (through collaboration or only in-house), the level of potentially complementary process innovations (high or low), the level of potentially complementary communication innovations (high or low), and the presence of an active management strategy to support innovation (yes or no).

Larger innovative agencies have more financial, human and intellectual resources to enable them to spread and absorb the risk and cost involved in innovation, compared to their smaller counterparts (Albury, 2005; Damanpour et al., 2009; Hartley et al., 2013). Furthermore, by dint of their size, larger agencies are more bureaucratic and formalized (Walker, 2014). Research suggests that formalized processes can make it harder to experiment with new ideas, but these same processes can make it easier to manage risk by enhancing predictability and reducing uncertainty, for instance when decisions are repeatedly scrutinized and responsibility shared through formal approval processes (Feeney and DeHart-Davis, 2009; Hartley, 2014; Ritchie, 2014). These size-related strategic advantages could make larger agencies less averse to the negative effects of risk and consequently better positioned to develop novel innovations with the potential to deliver high-value benefits. Nevertheless, in public services novel innovations are difficult to implement and are thus less common than incremental innovations (Hartley et al., 2013; Torugsa and Arundel, 2016b).

In the case of small agencies, in contrast, the limited resource base and the lesser formalization of decision-making processes (which make managers bear the cost of potential failure; Ritchie, 2014), could constrain organizational learning opportunities and consequently make it difficult for managers to minimize the negative effects of risk and hence to effectively operate in a high risk-averse culture (even for incremental changes). In such a case, small agencies with high-risk aversion would be less likely to obtain high benefits from their innovations, even with the use of appropriate strategies that allow them to manage risk.

A consistent finding of surveys on innovation in the public sector is the widespread use of collaboration with multiple partners drawn from different types of organizations (Bloch and Bugge, 2013; Gallup Organization, 2011) and the positive effects of collaboration on the benefits of innovation (Arundel et al., 2015; Torugsa and Arundel, 2016b). Despite its merits, collaboration is not cost-less. Government agencies are 'open systems' that are influenced by

and interact with a variety of stakeholders, each of whom places different (often conflicting and competing) demands and constraints on managers (Boyne, 2002; Torugsa and Arundel, 2016b). Hartley et al. (2013) also warn that a collaborative innovation strategy has limitations and could be unfeasible in some high-risk contexts where the political preference is for confidentiality. Collaboration could therefore be more effective when used in tandem with other strategies to manage risk.

Complementary process and communication innovations could represent important strategic mechanisms to positively influence the benefits of service innovations. Process innovations are concerned with how services are provided and can improve access or ease of use of a new service (Walker, 2014). Communication innovations involve new ways of promoting the agency or its services or new methods of influencing the behavior of service users, citizens, or other stakeholders (Hollanders et al., 2013). Furthermore, the presence of multiple (conflicting) goals and demands imposed on agency managers by numerous stakeholders makes service innovations more complex (Hartley, 2005) and likely to be more efficient and responsive to public needs when co-implemented with process and communication innovations. Such a co-implementation of different innovation types would allow agency managers to choose better ways to manage resources and to communicate with the public (e.g. for promoting good will or the uptake of a new service), increase the agency's capacity for adaptive change, and gain larger benefits from service innovations. Research on public sector innovation also suggests that complementary innovations can reinforce service innovation, fostering learning across different parts of an agency and resulting in beneficial synergies (Damanpour et al., 2009; Torugsa and Arundel, 2016a).

In risk-averse organizational environments, managerial attitudes to risk play a vital role in influencing staff perceptions and behaviors concerning risk (Bozeman and Kingsley, 1998). The benefits of innovation are likely to increase if agency managers implement an active management strategy to support innovation that encourages the experimentation and evaluation of new ideas, stimulates organizational learning, and facilitates the involvement of staff and users in the design or planning of new services. An active management strategy could increase the capacity of innovative agencies to work around risk, minimize and control its negative effects, and hence improve the agency's ability to innovate and collaborate in risk-averse organizational environments.

Summing up, agencies with a risk-averse organizational culture that have an integrated strategy involving collaborative innovation, complementary innovation and active management are likely to be able to engage with risk effectively, making innovation success more likely. Yet, whether all of these strategies must be present and deployed in an integrated way for high innovation benefits to be gained could be influenced by the agency size, the novelty of the innovation and the degree of risk aversion within the agency.

4. Data and analysis

4.1. Data

This study uses data from Innobarometer 2010, a telephone interview survey of innovation in randomly-selected public administration agencies across three levels of government (local/municipal, regional and national). The study was funded by the European Commission and conducted in 27 Member States of the European Union, plus Norway and Switzerland. The survey asked about innovation activities between January 2008 and October 2010. The target respondent was the agency head. Further methodological details and the survey questionnaire are available from the Gallup Organization (2011) (see http://ec.europa.eu/public_opinion/flash/fl_305_en.pdf).

The survey only covered public administration agencies with ten or more employees in NACE[1] class 84.11 (general public administration activities) and NACE class 84.12 (regulation of the activities of providing healthcare, education, cultural services, and other social services, excluding social security). As these NACE classes can include non-profit and private sector organizations, a survey question verified that the responding organization was a government agency, with non-governmental organizations excluded from the analyses. The study does not include specialized public organizations such as schools or hospitals that directly provide health and educational services to the public. However, public administrative agencies are directly responsible for all services within their remit and develop many of the services that are implemented by specialized public organizations. For example, public administration includes healthcare and education ministries that develop and fund education and health services and public agencies that provide many other types of public services. In our sample, for instance, 33% of the agencies are responsible, in part, for social services, 23% for the environment, 22% for culture, sport, or recreation, and 16% for housing.

The Innobarometer 2010 survey built on the experience of previous public sector innovation surveys in England (UK NAO, 2006) and Scandinavia (Bugge et al., 2011) and followed the Oslo Manual (OECD/Eurostat, 2005, p. 48) guidelines for measuring innovation by defining a service innovation as "the introduction of a service that is new or significantly improved with respect to its characteristics or intended uses". This definition spans the entire gamut of possible service innovations, ranging from highly novel or transformative innovations that make significant changes to current services to minor incremental changes. An example of an incremental service innovation would be the replacement of diesel buses with electric buses in a transportation system, whereas a transformative service innovation might introduce a zero emissions public transport system that is closely integrated with a range of other policies to significantly reduce carbon and nitrogen oxide emissions from all forms of transport, such as policies to support bikeways, share car schemes, road pricing and zero emissions goods transport.

In total, the survey received 3699 responses, of which 2505 (67.7%) reported the introduction of at least one service innovation. As this study focuses on how different levels of benefits from service innovations could be elicited in different risk-averse organizational cultures, the analyses are limited to a maximum of 2505 service innovators (in some analyses cases are lost due to missing values). Of note, given the exclusion of non-innovative agencies, we are unable to examine the effect of a risk-averse culture on entirely preventing service innovations. Of the 2505 agencies that reported service innovations, 76.5% served local/municipal areas while 16.2% and 7.3% operated at a regional or national level respectively.[2] Because a large majority of responses are from local agencies, nearly half of the sampled agencies (46%) have less than 50 employees.

The analyses follow a three-step process. The first step applies fuzzy-set QCA, an asymmetric set-theoretic method grounded in configurational theory, to identify the recipes (i.e. combinations of factors or strategies) used by high and low risk-averse innovators for achieving different levels of innovation benefits. To verify the QCA results, we conduct a series of descriptive analyses in the second step. The final step assesses the robustness of our

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[1] The statistical classification of economic activities in the European community.
[2] In a preliminary QCA analysis, we included the government level, coded as 1 for local-level agencies and 0 for regional- and national-level agencies, to reflect the different geographical areas of responsibility. However, as the inclusion of this factor diluted the solution consistency scores and resulted in a poor model fit, we decided to exclude this factor from the final analysis. This is consistent with the findings by Arundel et al. (2015) showing that the geographical areas of responsibility had no effect on the benefits of agencies' service innovations.

QCA results using sensitivity testing through predictive validity tests and ordered logit regression. This analytical process offers a pragmatic and rigorous way to investigate the effect of complex causality with multiple contingencies on innovation success.

4.2. Fuzzy-set qualitative comparative analysis

QCA conceptualizes cases as combinations (i.e., recipes) of attributes (i.e., factors or strategies) manifested by their set memberships (scores ranging from 0 for full non-membership to 1 for full membership), and uses Boolean algebra to identify all logically possible configurations for an outcome (i.e., levels of innovation benefits) (Fiss, 2011; Ragin, 2008). The method thus offers a middle path between 'case-based qualitative' methods (analyzing data by cases) and 'variable-based quantitative' methods (reducing a full case description to the minimum of causally relevant results to facilitate interpretation).

In fuzzy-set QCA, all possible configurations of attributes that are sufficient to generate an outcome are organized in a truth table, yielding 2^k rows (k equals the number of attributes) (Fiss, 2007, 2011; Ragin, 2008). Our study has seven attributes (i.e., risk aversion and six other factors), resulting in a truth table with 128 (2^7) rows or possible configurations of the seven factors. Reducing the rows of the truth table to an interpretable number requires selecting a consistency level and a frequency threshold. Consistency gauges the degree to which the cases share a recipe in displaying an outcome (comparable to a correlation [r] in statistics), while coverage (involving frequency) assesses the degree to which a recipe accounts for all cases of an outcome (comparable to r^2 in statistics) (Prado and Woodside, 2015). For our analyses, we selected a consistency cut-off of over 0.80 (above the recommended minimum of 0.75; Ragin, 2008) and used a frequency threshold of eight cases. Of note, in a trade-off between consistency and coverage scores, best practice stresses the importance of achieving high consistency over high coverage (Ragin, 2008).

4.3. Variables and models

Fuzzy-set QCA requires calibrating the multiple-value scales by specifying three thresholds: full non-membership in a set (0), full membership (1), and the crossover point of maximum ambiguity as to whether a case is more in or out of a set (0.5) (Ragin, 2008). Following Fiss (2011), our study calibrated all non-binary variables by setting cases in the 1st percentile as fully out, cases in the 99th percentile as fully in, and cases in the 50th percentile (i.e., median) as the crossover point.

The outcome of interest is a variable for the level of benefits from service innovations: high innovation benefits (High-InB) and low innovation benefits (Low-InB). The variable is constructed by multiplying the number of reported major benefits from service innovations by the intensity of service innovation. The former variable, with possible values ranging from 0 to 5, equals the sum of five 'major' benefits of the agency's new or significantly improved services, as reported by the survey respondents: "enabling your organization to offer services to more or new types of users", "enabling your organization to better target its services", "improving user satisfaction", "improving user access to information", and "enabling faster delivery of services". For the intensity of service innovation (values ranging from 1 to 4), respondents were asked to indicate the percentage of all services provided by their agency that were new or significantly improved in the previous two years, using a four-point scale: "less than 25%" (equal to 1), "between 25% and 49%" (2), "between 50% and 74%" (3), and "75% or more" (4). By multiplying these two constructs, the level of innovation benefits ranges from 0 (calibrated as fully out) to 20 (calibrated as fully in),

with a median value of 5 used as the crossover point (values above are set as High-InB and below as Low-InB).

The analyses examine the effect of a risk-averse culture and six other factors on the level of innovation benefits. Respondents were asked to indicate the importance of a risk-averse organizational culture in preventing or delaying their agency's innovations, using a four-point scale from 1 "not important" (calibrated as fully out) to 4 "high importance" (calibrated as fully in) with a crossover/median value of 3 "medium importance" (values above are set as high risk aversion: HighRA).

The second factor is the agency size, coded as 1 for larger (medium-to-large) agencies with 50 employees or more (LSize), and 0 for small agencies with 10–49 employees. The third factor is the novelty of service innovation, coded as 1 if the respondent's organization had "introduced a new service innovation before any other public administration in your country" in the previous two years (NovIn) and 0 if they were only new to the agency. This variable is not a direct measure of the concept of transformative public sector innovations discussed by Potts (2009) and Osborne and Brown (2011), but the category of 'new to the country' service innovations is likely to include more ambitious innovations and fewer agency-specific incremental innovations, often developed by front-line staff (Fuglsang, 2010), than the alternative category. The fourth factor is the method of developing service innovations, coded as 1 if the agency developed new services together with at least one of three external organizations including other public sector organizations, private businesses, and not-for-profit organizations (Collab), and 0 if new services were developed in-house only (including adoption of services from other organizations with the agency making no further changes or only minimal changes).

The level of potentially complementary process innovations was measured as the sum of five types of new or significantly improved processes or organizational methods: "methods of providing services or interacting with your users", "delivery or logistics systems for your inputs", "supporting activities such as maintenance systems, purchasing, accounting, or computing systems, etc.", "management systems", and "methods of organizing work responsibilities or decision making", with values ranging from 0 (calibrated as fully out) to 5 (calibrated as fully in) and a crossover/median value of 3 (values above are set as high process innovation: HighPcIn). The level of potentially complementary communication innovations equals the sum of two types of new or significantly improved methods of communicating activities to the public: "methods of promoting your organization or your services" and "methods of influencing the behavior of users, citizens or others", with values ranging from 0 (calibrated as fully out) to 2 (calibrated as fully in) and a crossover value of 1 (values above are set as high communication innovation: HighComIn).

The last factor is an active management strategy to support innovation. Respondents were asked to indicate if each of five innovation support strategies were "not at all" (equal to 0), "partly" (equal to 1) or "fully" (equal to 2) implemented. The five strategies are: "managers support trial-and-error testing of new ideas", "managers takes an active role in developing and implementing innovations", "staff have incentives to think of new ideas and take part in their development", "users are involved in the design or planning of new or improved services", and "new or improved services are evaluated after completion". We summed the values of each of these five strategies with the aggregate values ranging from 0[3] to 10, and multiplied these aggregate values by a second question, the level of importance of "ideas from management" as a key source for the development of innovation (1 = low, 2 = medium, and

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[3] 1.6% of 2505 agencies get a score of zero.

3 = high) to form the variable for an active management strategy. This variable thus has a scale from 0 (calibrated as fully out) to 30 (calibrated as fully in) with a crossover/median value of 15 (values above are set as an active management strategy: AcMgmt).

This study tests two fuzzy-set QCA models (main and negation [∼] models):

High-InB = (HighRA, LSize, NovIn, Collab, HighPcIn, HighComIn, AcMgmt)

Low-InB (∼High-InB) = (HighRA, LSize, NovIn, Collab, HighPcIn, HighComIn, AcMgmt)

Ragin (2008) recommends the examination of necessity separately from the analysis of sufficiency (configurations of factors) to avoid mistakenly interpreting a factor that occurs in every sufficient configuration as a necessary condition. For QCA using large data sets, a necessary condition should have a consistency greater than 0.8 and a coverage more than 0.5. The results of the test of necessity reveal two necessary conditions for high innovation benefits to occur: high communication innovation (consistency = 0.88), and collaboration (consistency = 0.85). No necessary condition for low innovation benefits is observed.

5. Results

The QCA results (Table 1) show four configuration solutions (recipes) that lead to high levels of innovation benefits (High-InB). All configurations have acceptable consistency levels (over 80% of cases in each solution term is a subset of the outcome) and the combined solution coverage accounts for 48% of membership in the outcome for High-InB[4]. High communication innovation (HighComIn) and collaboration (Collab) are the only two factors appearing in all solutions, confirming the results of the necessity test and highlighting their importance as the basic building blocks for highly beneficial service innovations. Yet these two factors, while necessary, are not sufficient as their capacity to produce high innovation benefits depends on their alignment with other factors in a recipe.

Both high and low risk-averse innovators can achieve large benefits from their innovation efforts, but their strategizing behaviors differ, partly due to the impact of organizational size on their ability to manage their agency's risk aversion. Specifically, there are three solutions for larger agencies (solutions 1–3) and only one solution for small agencies (solution 4) to achieve high innovation benefits. For larger agencies (>50 staff), novel innovations (NovIn) only offer high benefits *either* in the presence of a low risk-averse organizational culture (absence of high risk aversion) combined with an active management strategy and deployed in tandem with the two necessary strategies (i.e., Collab and HighComInn) (solution 2), *or* with combined 'collaborative innovation' (Collab) and 'complementary innovation' (HighPcIn and HighComIn) strategies (solution 1). In the latter recipe, a high risk-averse culture can be present or absent (indicated by a blank). Notably, these results also suggest that an active management strategy is essential to obtaining high innovation benefits from a novel innovation under conditions of a low risk-averse culture and larger agency size.

For larger agencies with a high risk-averse culture (solution 3), the only way for high innovation benefits to occur is through what we define here as an *integrated strategy* that holistically combines the 'collaborative innovation', 'complementary innovation' and 'active management' strategies. For small agencies (10–49 staff), the only solution that provides high innovation benefits is to deploy the integrated strategy in a low risk-averse organizational culture (solution 4). This recipe suggests two key points: first, small

agencies are unable to gain large benefits from their innovation efforts in the presence of high risk-averse organizational cultures; and second, an integrated strategy allows small agencies to obtain high benefits for either incremental or novel innovations (the value for 'NovIn' is blank indicating no preference).

Table 2 gives six solutions that lead to low innovation benefits (Low-InB). All solutions have a consistency greater than 0.87 and the solution coverage is 0.43. The configuration solutions for Low-InB are not the mirror opposites of those for High-InB, suggesting that the patterns of relationships among the seven factors are asymmetric. For five of the six solutions innovation novelty is low and there is no preference for novelty in solution six. There is only one solution where larger agencies (solution 1) fail to obtain high benefits from service innovations, but five solutions for small agencies (solutions 2–6). Interestingly, a low risk-averse culture impedes high benefits from service innovations in three recipes (solution 1 for large agencies and solutions 5–6 for small agencies), but a high risk-averse culture is not a determining factor in preventing high benefits in solutions 2–4.

For larger agencies (solution 1), the presence of a low risk-averse culture, even when combined with collaboration, only results in low innovation benefits if the innovation is incremental and the level of process innovation is low. For small agencies, the absence of an integrated strategy, combined with a low risk-averse culture (solutions 5–6) or even not taking risk aversion into account (solutions 2–4), results in low innovation benefits.

The QCA results show that the level of organizational risk aversion is a relevant but not deterministic factor (neither necessary nor sufficient) for innovation to be successful (High-InB) or unsuccessful (Low-InB). Rather, the capacity of public agency managers to develop a set of strategies that are likely to manage risk effectively (especially an integrated strategy) matters for innovation success. Yet the ability to develop this capacity can be affected by organizational size. In the next section, we provide a series of descriptive results to help explain the QCA results for the strategic behavior of agencies with high and low risk-averse cultures and for novel and incremental innovations. For these analyses, calibrated variables were transformed into binary (0/1) variables using the crossover point (values above are set as 'high' and values below or equal are set as 'low').

5.1. Descriptive results

As shown in Table 3 and in line with the QCA results, there is no significant difference by level of organizational risk aversion in the share of agencies achieving high innovation benefits. Even so, a significantly higher percentage of agencies with a high risk-averse culture (34.4%) develop a novel innovation than agencies with a low risk-averse culture (28.2%). Interestingly, high and low risk-averse agencies significantly differ in their use of methods to support service innovation, except collaboration where over 80% of both groups engage in this strategy. Specifically, the share of high risk-averse innovators that possess high levels of process and communication innovations, deploy an active management strategy, and more importantly have an integrated strategy in place, is significantly higher than the share of low risk-averse agencies. These results suggest that managers in high risk-averse organizations are capable of introducing strategies to manage risk.

Table 4 gives the percentage of organizations by size and managers that report the use of each innovation strategy by the benefits of service innovations and the presence of a novel innovation. Consistent with the QCA results, high innovation benefits and novelty are correlated with the use of strategies for effective risk-innovation engagement and agency size. These factors are more strongly correlated with high innovation benefits than the level of risk aversion (shown in Table 3). The descriptive results for

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[4] This solution coverage is similar to the levels reported in other large-scale QCA studies, e.g. Prado and Woodside (2015).

Table 1
Recipes for HIGH innovation benefits.

Configuration model (solution)	Outcome variable: High-InB							Coverage		Consistency
	HighRA	LSize	NovIn	Collab	HighPcIn	HighComIn	AcMgmt	Raw	Unique	
1		●	●	●	●	●		0.173715	0.032535	0.807999
2	□	●	●	●		●	●	0.121913	0.008386	0.841016
3	●	●		●	●	●	●	0.255702	0.152323	0.879835
4	□	□		●	●	●	●	0.142488	0.142486	0.859283

Solution coverage: 0.476912
Solution consistency: 0.835110

Notes: Black circles "●" indicate the presence of a condition. Squares "□" indicate the absence of a condition. Blank cells indicate an irrelevant ("don't care") condition.

Table 2
Recipes for LOW innovation benefits.

Configuration model (solution)	Outcome variable: Low-InB							Coverage		Consistency
	HighRA	LSize	NovIn	Collab	HighPcIn	HighComIn	AcMgmt	Raw	Unique	
1	□	●	□	●	□			0.145498	0.145496	0.883255
2		□	□	●	●	●	□	0.108274	0.036830	0.897883
3		□	□	●	□	●	●	0.085767	0.017767	0.903947
4		□	□	□	□	●	□	0.054634	0.010831	0.900248
5	□	□	□		□		□	0.185406	0.048045	0.903412
6	□	□		●	□	●	□	0.125272	0.031714	0.910002

Solution coverage: 0.434811
Solution consistency: 0.874474

Notes: Black circles "●" indicate the presence of a condition. Squares "□" indicate the absence of a condition. Blank cells indicate an irrelevant ("don't care") condition.

Table 3
Strategic behavior of innovative agencies by level of organizational risk aversion.

	N[a]	Percentage in row (%)							
		High innovation benefits	Novel innovation	Larger agency size	Collaboration	High process innovation	High communication innovation	Active management strategy	Integrated strategy[b]
High risk aversion	515	33.7	34.4	51.4	81.0	54.2	66.6	51.0	25.6
Low risk aversion	1873	37.4	28.2	55.4	81.7	44.2	56.7	42.9	17.0
Chi-square (1df)		*3.81*	*6.63**	*2.64*	*0.13*	*16.14****	*16.35****	*10.63****	*19.5****

[a] 117 'DN/NA' responses excluded.
[b] Integrated strategy = collaboration & high process innovation & high communication innovation & active management strategy.
** $p < 0.01$.
*** $p < 0.001$.

organizational size (see Table 5) show that there is no significant difference in the share of larger versus small agencies that are highly averse to risk. However, larger agencies are more likely than their smaller counterparts to use each type of innovation support strategy, introduce novel innovations, and gain large benefits from their innovation efforts.

5.2. Predictive validity and ordered logit regression

The usefulness of a QCA model depends on its predictive accuracy. We follow Woodside et al.'s (2013) recommendations by testing for predictive validity by randomly splitting the whole sample ($n = 2505$) into two approximately equal subsamples. We then run a series of fuzzy-set QCA models on each subsample to assess the robustness of the configuration solutions reported in Tables 1 and 2 in predicting the same outcome. Table 6 presents the results for the two subsamples ($n = 1253$ for sample 1, and $n = 1252$ for sample 2) for both high and low levels of innovation benefits. For each subsample, all of the solutions have high consistency (>0.80) and similar coverage, indicating that the study's main findings of configuration solutions have acceptable predictive validation.

To further assess the usefulness of QCA in identifying complex combinations among multiple factors, we compare the QCA findings with those from ordered logit regression. Table 7 provides the ordered logit results that predict the 'net' effect of seven individual variables (Model 1) and of ten configured variables derived from the QCA analyses (Model 2) on innovation benefits. To make the results comparable, the individual variables included in Model 1 are membership scores calibrated in QCA (replacing calibrated scores with original scores gave the same results as calibration), while the configured variables included in Model 2 are the fuzzy-set scores of the configuration solutions found in Tables 1 and 2Tables 1 (High-InB) and 2 (Low-InB).

Model 1 of Table 7 shows a significant positive effect for all except two variables. The non-significant effect of risk aversion supports the QCA findings that a high risk-averse culture is not important in 3 of the 4 solutions for high innovation benefits (although it does not support solution 3), while the non-significant effect of collaboration is due to the fact that more than 80% of the agencies in the sample reported collaboration on innovation. Of note, the effect of collaboration is significant and positive if the binary variable used in Model 1 is replaced with an ordinal variable

Table 4
Benefits and novelty of innovation by size and strategy.

	N	Percentage in row (%)	
		High innovation benefits	Novel innovation
Novel innovation[a]	656	44.6	
Incremental innovation	1550	27.4	
Chi-square (1df)		58.85***	
Larger agencies[b]	1349	36.0	34.5
Small agencies	1145	30.9	24.3
Chi-square (1df)		6.89**	27.20***
Collaboration[c]	1953	36.6	33.9
In-house	446	24.8	16.0
Chi-square (1df)		20.85***	49.17***
High process innovation	1144	44.1	40.6
Low process innovation	1361	24.9	21.1
Chi-square (1df)		96.53***	98.38***
High communication innovation	1463	41.0	36.3
Low communication innovation	1042	23.4	20.6
Chi-square (1df)		78.6***	63.19***
Active management strategy[d]	1084	41.9	38.9
Non-active management strategy	1368	27.8	22.4
Chi-square (1df)		50.11***	69.91***
Integrated strategy	464	54.7	51.9
Non-integrated strategy	1988	29.2	24.5
Chi-square (1df)		102.67***	117.50***

[a] 299 'DN/NA' responses excluded.
[b] 11 'DN/NA' responses excluded.
[c] 106 missing/invalid responses (reporting 'DN/NA' or 'no' to all the questions on methods of developing innovation).
[d] 53 missing data.
** $p < 0.01$.
*** $p < 0.001$.

Table 5
Strategic behavior of innovative agencies by size.

	N[a]	Percentage in row (%)							
		High innovation benefits	Novel innovation	High risk aversion	Collaboration	High process innovation	High communication innovation	Active management strategy	Integrated strategy[b]
Larger agencies	1349	36.0	34.5	20.4	86.4	54.9	63.2	50.6	23.7
Small agencies	1145	30.9	24.3	23.1	75.2	34.8	52.8	36.5	13.2
Chi-square (1df)		6.89**	27.20***	2.64	48.4***	99.92***	28.01***	49.07***	43.34***

[a] 11 'DN/NA' responses excluded.
[b] Integrated strategy = collaboration & high process innovation & high communication innovation & active management strategy.
** $p < 0.01$.
*** $p < 0.001$.

Table 6
Predictive validity.

	Subsample 1		Subsample 2	
	Consistency	Coverage	Consistency	Coverage
Test of models for High-InB				
LSize*NovIn*Collab*HighPcIn*HighComIn	0.810344	0.209753	0.803382	0.219696
~HighRA*LSize*NovIn*Collab*HighComIn*AcMgmt	0.834403	0.149109	0.824951	0.154402
HighRA*LSize*Collab*HighPcIn*HighComIn*AcMgmt	0.874033	0.254705	0.874445	0.262375
~HighRA*~LSize*Collab*HighPcIn*HighComIn*AcMgmt	0.850185	0.147301	0.856086	0.149937
Overall solution	*0.839866*	*0.494149*	*0.838821*	*0.504745*
Test of models for Low-InB				
~HighRA*LSize*~NovIn*Collab*~HighPcIn	0.890953	0.159720	0.863588	0.139706
~LSize*~NovIn*Collab*HighPcIn*HighComIn*~AcMgmt	0.890188	0.113159	0.885362	0.117762
~LSize*~NovIn*Collab*~HighPcIn*HighComIn*AcMgmt	0.909676	0.086088	0.889845	0.099065
~LSize*~NovIn*~Collab*~HighPcIn*HighComIn*~AcMgmt	0.898080	0.061173	0.913823	0.064610
~HighRA*~LSize*~NovIn*~HighPcIn*~AcMgmt	0.896199	0.195220	0.896165	0.208878
~HighRA*~LSize*Collab*~HighPcIn*HighComIn*~AcMgmt	0.903581	0.130121	0.902166	0.135190
Overall solution	*0.878928*	*0.457363*	*0.859390*	*0.448668*

The symbol [~] denotes negation or the absence of a condition. The symbol [*] represents Logical "AND".

Table 7
Ordered logit regression on innovation benefits.

	b	S.E.	P > |z|
Model 1: individual variables			
HighRA (high risk aversion)	−0.162	0.128	0.206
LSize (larger agencies)	0.174	0.084	0.038
NovIn (novel innovation)	0.290	0.092	0.002
Collab (collaboration)	0.130	0.107	0.224
HighPcIn (high process innovation)	1.371	0.152	0.000
HighComIn (high communication innovation)	0.925	0.137	0.000
AcMgmt (active management strategy)	1.010	0.161	0.000
LR X^2(7) = 387.10; Prob > X^2 = 0.000; Log likelihood = −4205.928; Pseudo R^2 = 0.044			
Model 2: configured variables			
Configuration solutions for HIGH benefits[a]			
1. LSize*NovIn*Collab*HighPcIn*HighComIn	0.152	0.213	0.475
2. ~HighRA*LSize*NovIn*Collab*HighComIn*AcMgmt	1.041	0.296	0.000
3. HighRA*LSize*Collab*HighPcIn*HighComIn*AcMgmt	1.586	0.220	0.000
4. ~HighRA*~LSize*Collab*HighPcIn*HighComIn*AcMgmt	1.860	0.285	0.000
Configuration solutions for LOW benefits[b]			
5. ~HighRA*LSize*~NovIn*Collab*~HighPcIn	−0.806	0.189	0.000
6. ~LSize*~NovIn*Collab*HighPcIn*HighComIn*~AcMgmt	0.089	0.274	0.745
7. ~LSize*NovIn*Collab*~HighPcIn*HighComIn*AcMgmt	0.146	0.347	0.674
8. ~LSize*~NovIn*~Collab*~HighPcIn*HighComIn*~AcMgmt	0.187	0.320	0.559
9. ~HighRA*~LSize*~NovIn*~HighPcIn*~AcMgmt	−1.598	0.229	0.000
10. ~HighRA*~LSize*Collab*~HighPcIn*HighComIn*~AcMgmt	0.079	0.311	0.800
LR X^2(10) = 321.84; Prob > X^2 = 0.000; Log likelihood = −5318.983; Pseudo R^2 = 0.029			

Notes: The symbol [~] denotes the absence of a factor. The symbol [*] represents Logical "AND".

[a] Multicollinearity problems exist between configured variables 1 and 2 (r = 0.78).

[b] High correlations exist between configured variables: 9 and 10 (r = 0.67), 7 and 10 (r = 0.64), 9 and 6 (r = 0.62), 9 and 8 (0.61), and 7 and 6 (r = 0.62).

for the number of collaboration partners (0–3), but this substitution eliminates the significant effect of organizational size. Overall, these results suggest that the 'net effects' assumption of regression techniques (e.g. ordered logit), which treat variables as competing in explaining variation on an outcome, can cause misleading conclusions. For example, the ordered logit results using a binary variable for collaboration would result in the incorrect conclusion that collaboration, employed by the majority of agencies, is not an important strategy for innovation success, whereas the QCA results in Table 1 show that collaboration is required in all four solutions for high innovation benefits.

In regard to Model 2 of Table 7, a significant effect on innovation benefits is observed in five of the ten configurations (three positive and two negative effects). Of note, as regressions assume causal symmetry, with the result that a negation model must be the mirror opposite of a positive outcome model, we would expect a negative effect of the configured variables for Low-InB on innovation benefits. The non-significant effect of several configurations is a result of multicollinearity problems, decreasing the stability and significance of coefficient estimates. Specifically, multicollinearity exists between configured variables 1 and 2 (r = 0.78), and high interdependence of variables (r > 0.60) is found between five pairs of configured variables for Low-InB (variables: 9 and 10, 7 and 10, 9 and 6, 9 and 8, and 7 and 6). Our comparison of the QCA and ordered logit results thus suggest limitations in using regressions to explore complex configurational phenomena.

6. Discussion and conclusions

To date, almost all research on the effect of risk on public service innovation is based on conceptual theorizing or on a limited number of case studies (Brown and Osborne, 2013). To the best of our knowledge, this is the first study to use a large survey of several thousand public administration agencies to investigate the relationship between a culture of risk aversion and the benefits agencies obtain from service innovations. Using a holistic and multiple contingencies approach grounded in configurational theory, this study applies fuzzy-set QCA to explore how different levels

of risk aversion combine with other factors and innovation support strategies to produce high and low levels of innovation benefits. The analyses identify four equifinal configurations of factors leading to high innovation benefits and six equifinal configurations for low innovation benefits. The level of risk aversion is a relevant but not deterministic condition for the successful development of service innovations that elicit high benefits. Rather, the ability of an innovative agency to deploy and properly combine different strategies, based on the context in which it operates, is a fundamental driver for innovation success.

To maximize the benefits of service innovations, collaborative and communication innovations must be present, possibly because these two methods for supporting service innovations minimize the negative effects of risk. In respect to collaboration, the process of innovation in the public sector often proceeds by trial and error (Borins, 2001; Pärna and Von Tunzelmann, 2007) and therefore support from multiple collaboration partners can help define common problems and develop better solutions (Hartley et al., 2013; Osborne and Brown, 2011; Torugsa and Arundel, 2016a). The goal of openness and transparency in public administration creates a need for agencies to develop new methods of communicating their service innovations to the public, which is the major user of these services. This communication process is likely to build good will, reduce negative scrutiny, and improve access and understanding of innovative services by users, thereby improving the uptake, user satisfaction and other benefits from service innovations (Hollanders et al., 2013). Yet, the use of collaboration and communication innovations, while necessary, are not sufficient by themselves to elicit high innovation benefits. These strategies are effective only when used in tandem with two or more other factors (high process innovation, an active management strategy or novel innovation) and their effectiveness is contingent upon the level of organizational risk aversion and the size of the agency.

Larger agencies can achieve high benefits from their service innovations in a low risk-averse culture if a novel service innovation is developed and in a high risk-averse culture if managers are able to combine collaborative innovation, complementary innovation and active management strategies into an integrated strategy. Small agencies can achieve high benefits from their service inno-

vations only in a low risk-averse organizational culture combined with an integrated strategy.

The strategic behaviors of managers in high and low risk-averse agencies differ significantly. Managers in high risk-averse organizations exhibit a higher propensity to develop an integrated strategy and consequently they are likely to be able to work effectively around risk, to develop novel innovations, and hence to obtain high benefits from their service innovations. These findings challenge the traditional assumption that a risk-averse culture in public agencies is a cause of management ineffectiveness and a significant barrier to successful innovation (Brown and Osborne, 2013; Potts, 2009; Ritchie, 2014). Our findings thus have significant implications for theory, management and policy.

6.1. Theoretical implications

The results of this study reveal that there is no single exclusive path leading to high (or low) innovation benefits, with multiple solutions in how factors or strategies are combined (showing causal asymmetry), and that the choice of which paths to choose should be guided by the context in which agencies operate. These results support configurational theory and demonstrate the usefulness of QCA. Compared to ordered logit regression (based on the net effects assumption), QCA provides an alternative analytical approach that can capture a more nuanced picture of how outcomes are influenced by combinations of different factors.

The study finding that a high level of organizational risk aversion does not prevent managers from obtaining high benefits from public service innovations also lends support to the 'revealed barriers' notion of D'Este et al. (2012). This finding has two-fold significance. First, an agency's risk-averse culture should not be interpreted as blocking innovation success if managers can implement strategies that allow them to manage and engage with risk in an effective manner. Second, a risk-aware culture should be encouraged where risk management is seen as an integral, positive part of decision-making (rather than a corrective measure) on an agency's innovation activities and thus as a tool for overcoming the barriers to success.

6.2. Managerial implications

Our findings are of value to the managers of both large and small public administration agencies with a risk-averse culture. The results suggest that the managers of larger agencies should give resource priority to the development of novel innovations if their organization is low risk-averse, but in the presence of high risk aversion, the development of an integrated strategy combining collaboration, complementary process and communication innovations and an active management strategy to support innovation is a must.

For managers of small agencies, in contrast, the development of novel innovations can prove difficult for managers, especially if they work in a high risk-averse organizational environment. Novel innovations demand greater levels of change and thus can generate higher levels of risk compared to incremental innovations (Brown and Osborne, 2013). Resource and budget constraints in small agencies can stiffen a culture of risk aversion and create barriers that impede the ability of managers to innovate successfully (Hartley, 2014). For small agencies, large benefits can be gained from service innovations (with no preference for novelty) if managers implement an integrated strategy and are in a low risk-averse environment.

6.3. Policy implications

Concerns over risk in the public sector often lead public agencies to develop rules to maintain standards that consequently create a heightened organizational aversion to risk. This high level of risk aversion has often been identified as a major impediment to innovation. Case study research by Kay and Goldspink (2012) has shown that public managers have tools for circumventing problems such as an uncertain environment (which could increase the risks they face). In their research these tools include the ability of managers to use collaboration and time to innovate carefully. The results of our study support Kay and Goldspink (2012) and challenge the view that organizational risk aversion in the public sector is a stumbling block to innovation success. Instead, public managers could introduce successful innovations in high risk-averse conditions by moving beyond simple solutions through adopting combinations of context-specific factors that create an integrated strategy for innovation, and by shifting from erring on the side of caution to being aware of risks and carefully managing them to mitigate adverse effects.

Therefore, our findings invite policy-makers to reconsider the notion of risk aversion and risk-taking in public agencies. While a public service culture has traditionally been risk averse, it does not follow that public managers are unable to work effectively around risk and achieve high benefits from innovations. The effectiveness of an integrated innovation strategy in supporting innovations in risk-averse agencies suggests that policy should foster effective innovation in public services by providing support and training to managers to assist in: (1) the development of context-specific sets of strategies that can support innovation in agencies with various levels of risk aversion, and (2) the transition from risk aversion to risk awareness and effective risk management.

6.4. Limitations and directions for future research

This study has several limitations that point to future research. First, due to the nature of the data available, this study is limited by its focus on a risk-averse organizational culture perceived by managers working in innovative agencies and on a limited choice of factors that managers can use to manage risk. We are unable to test the effect of actual instances (or objective indicators) of risk aversion and other factors (e.g. political control, bureaucratic structures, and levels of formalization) on innovation benefits or to determine if these factors deter the development of innovation in non-innovative agencies. Second, respondent perceptions of organizational risk aversion could also be influenced by their own personal attitudes to risk, a variable that is not available in our data and therefore cannot be controlled for in our analyses. The effect of a failure to control for personal attitudes to risk is to reduce the ability of our study to detect effective strategies to work around risk. For example, a manager that states that his or her organization is risk averse on the basis that he or she is risk averse should have little motivation to find ways to manage risk, particularly for novel and more risky innovations. Such a manager should tend to introduce less risky incremental innovations, which will reduce the probability of identifying methods that managers in high risk-averse organizational cultures use to implement novel innovations.

Third, the data are limited to public administration agencies within Europe and consequently the findings may not be generalizable to other types of public sector organizations (e.g. hospitals and schools) or to non-European countries. Fourth, our results are limited by the use of self-reported measures from managers of innovation benefits. Public agencies rarely collect high quality quantitative data on the benefits of service innovations, such as a reduction in costs per service, making it difficult to measure such benefits (Arundel and Huber, 2013; Hartley et al., 2013). Also, as a common driver for public service innovation is public demand for new services, a lack of data from the public on the benefits of innovations is a weakness of this study. Finally, as with regression

techniques, QCA has methodological limitations. For example, the results are sensitive to the selection of factors and cases, as well as the selected thresholds for consistency, coverage and the crossover point. Therefore, QCA relies heavily on the researcher's subjective judgments, which could lead to bias. To address this, we used careful sensitivity testing to minimize potential bias and are confident in the robustness of the results.

The limitations in this study point to the need for more rigorous studies on the configurations of multiple risk factors in the public sector and risk-engaging strategies that result in innovation success for innovators, and on the configurations of risk-related factors that result in innovation failure for non-innovators. Such studies should yield useful insights that enhance the capabilities of public sector agencies to work effectively around risk and gain high-value benefits from service and other types of innovations.

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