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How European public sector agencies innovate: The use of bottom-up, policy-dependent and knowledge-scanning innovation methods

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ABSTRACT

Factor and cluster analysis are used to identify different methods that public sector agencies in Europe use to innovate, based on data from a 2010 survey of 3273 agencies. The analyses identify three types of innovative agencies: bottom-up, knowledge-scanning, and policy-dependent. The distribution of bottom-up agencies across European countries is positively correlated with average per capita incomes while the distribution of knowledge-scanning agencies is negatively correlated with income. In contrast, there is no consistent pattern by country in the distribution of policy-dependent agencies. Regression results that control for agency characteristics find that innovation methods are significantly correlated with the beneficial outcomes of innovation, with bottom-up and knowledge-scanning agencies out-performing policy-dependent agencies.

1. Introduction

The public sector contributes to between 20% and 30% of GDP in economically developed countries (Eurostat, 2012). Given its economic weight, there is growing policy interest in how to encourage public sector innovation in order to improve productivity, the efficiency of service delivery and the quality of public services. This interest has led to government support for surveys to measure public sector innovation in the UK (Mulgan, 2007; Hughes et al., 2011), Australia (Arundel and Huber, 2013), Scandinavia (Bloch and Bugge, 2013) and Europe (European Commission, 2011). Most of these surveys have been inspired by the Oslo Manual's (OECD/Eurostat, 2005) recommendations for measuring innovation in the private sector, with questions on innovation inputs, activities and outputs.

The goal of measuring public sector innovation is to inform policies to improve the innovation capacity and outputs of agencies (for simplicity we replace 'public sector organization' with 'agency'). An important step is to determine if there is heterogeneity in how agencies innovate, as observed for the private sector in studies using data from innovation surveys or specific innovations (Pavitt, 1984; Veugelers and Cassiman, 1999; Leiponen and Drejer, 2007). If there is heterogeneity in the innovative capabilities of agencies, there should be opportunities for learning which approaches to innovation produce the best outcomes such as improvements to service quality or process efficiencies.

An evaluation of differences in how agencies innovate depends on how innovation is defined. Major disruptive innovations such as the introduction of national healthcare programs require political legislation. Yet other types of disruptive innovations, such as replacing mailed tax returns or government surveys with automated online versions may or may not depend on legislation or directives. In addition, many incremental innovations such as efficiency improvements to service delivery or administrative processes could be developed and implemented at the agency level. New governance structures were introduced in many developed countries from the 1980s to encourage managerial initiatives to introduce efficiency-enhancing innovations and more recently there has been interest in other forms of governance to encourage innovation (Hartley et al., 2013).

In this article we use the results of a large survey of the innovation activities of European public administration agencies to determine if there are systematic differences in how agencies innovate and the nature of these differences. The survey followed the Oslo Manual in using a broad definition of innovation that encompasses incremental innovations through to major disruptive innovations, with innovation broadly defined as 'a new or

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significantly improved service, communication method, or process/organizational method'. We evaluate three research questions.

First, are there differences in how agencies innovate and if yes, how do these approaches vary? Second, do differences in how agencies innovate vary in a consistent pattern across countries, perhaps in response to different bureaucratic or cultural traditions? Our analyses for these first two research questions identify three different methods that agencies use to innovate: 'bottom-up', 'knowledge-scanning', and 'policy-dependent' methods. The prevalence of the first two methods varies consistently across European countries, while there is no consistent difference for policy-dependent innovation. Of note, these analyses are largely exploratory, due to the absence of a developed theory and previous research on heterogeneity in the innovative methods used by agencies.

The third research question is if these three innovation methods are linked to innovation outputs or outcomes, such as the novelty of innovations and the benefits of innovation. The results indicate that the 'bottom-up' and 'knowledge-scanning' methods are correlated with better outcomes than the 'policy-dependent' approach. To the best of our knowledge, this is the first empirical study of the first and second research questions and the first study to use survey data for multiple countries to examine the link between how agencies innovate and innovation outcomes.

2. Heterogeneity of the innovative activities of public sector agencies

There are several reasons why we would expect agencies to exhibit heterogeneity in their innovative activities, both within countries and across countries. These include differences in governance, cultural factors, and the discretionary power given to managers.

The traditional governance structure for the public sector limits innovation to a 'top down' process driven by political decisions (Hartley, 2005; Walker, 2006), although senior managers may have some room to influence how legislated change or ministerial directives are implemented. Due to concerns that this approach stifled innovation, New Public Management (NPM) was introduced in many countries in the 1980s to give managers greater responsibility for implementing efficiency-enhancing innovations, but Hartley et al. (2013) argue that NPM discouraged knowledge sharing across organizations and consequently acted to hinder some types of innovations. Failures with some of the main features of NPM, such as splitting up government hierarchies, competition markets, and incentive systems also encouraged the development of alternative governance methods (Dunleavy et al., 2005; Moore and Hartley, 2008), such as 'organizational entrepreneurship' which encourages 'bottom up' processes that involve both middle managers and front-line staff in innovation, 'whole of government' or 'joined up government' systems that stress collaboration across agencies, and 'lateral innovation' where agencies adapt good practices in use by other agencies (Hartley, 2005). Christensen and Laegreid (2007) also identify methods in which agencies develop innovations through 'networked governance' that includes collaboration with both other agencies and non-governmental organizations. Sorensen and Torfing (2012) refer to a new 'governance network method' for public sector innovation that draws on the expertise of front-line staff, managers, private businesses, users and others.

These different governance structures are likely to diffuse at varying rates across countries. NPM was first adopted by Anglo-Saxon countries and later taken up to varying degrees by European governments (Hartley et al., 2013). We would expect similar differences in diffusion rates for methods based on organizational entrepreneurship or lateral innovation.

2.1. Contextual factors: organization and culture

Contextual factors create the environment in which agency managers operate (Walker, 2006). In addition to differences in governance, there is some evidence that national differences in how work is organized, the national culture, and organizational conditions can influence how agencies innovate.

Research using the European 2000 Survey of Working Conditions found large differences among 14 European Union (EU) countries in the level of responsibility given to private-sector employees (Arundel et al., 2007). In Sweden, Denmark and The Netherlands over 50% of employees worked in 'discretionary learning' organizations that provide staff with high levels of responsibility to solve problems, while in Greece, Italy, Spain, and Portugal less than 30% of employees worked under these conditions, with an above average share of employees working in Taylorist or traditional organizations where work is either routine or involves low levels of problem solving. The study found a positive correlation between the national share of employees working in discretionary learning organizations and the share of highly innovative firms.

If working conditions in the public sector partly reflect conditions in the private sector, we would expect higher shares of public sector employees working in 'discretionary learning' agencies in Scandinavia than in Southern Europe. These working conditions could also support agency activities to develop innovations, as suggested by the results for the private sector. Conversely, agencies in Southern Europe could partly replicate the traditional organizational structures of their private sector counterparts, resulting in fewer opportunities for employees to think of and suggest innovative solutions of relevance to their workplace.

A related factor that could create national differences in how agencies innovate is the national culture. Hofstede's (2011) four dimensions of power distance, uncertainty avoidance, individualism versus collectivism, and masculinity versus femininity have been found to be correlated with several indicators of innovation, such as per capita patent application rates at the EPO (Kaasa and Vadi, 2010), the willingness of individuals to buy innovative products (Steenkamp et al., 1999) and the innovative output of firms (Rosenbusch et al., 2011). In general, innovation is negatively correlated with power distance, uncertainty avoidance and masculinity and positively correlated with individualism. A high level of power distance, or a more hierarchical society, is expected to reduce information sharing and consultation with employees, high uncertainty avoidance to create fewer incentives for developing novel ideas, and high masculinity to reduce collaboration, with these factors depressing innovative activity. Conversely, high individualism is thought to support novelty-seeking behavior that increases innovative activity. Societies with low power distance and high individualism, such as in Northern Europe (Kaasa, 2013), could also be more likely to have a higher percentage of workplace environments that give employees greater responsibility to develop innovative solutions to problems.

Other conditions that are common in the public sector could impede innovation. Regulatory requirements could limit opportunities for innovation in the delivery of health, taxation or security services (Borins, 2006; Mulgan and Albury, 2003; Koch and Hauknes, 2005). In addition, strong bureaucracies and high levels of red tape can create organizational cultures that are unreceptive to innovation (Boyne, 2002), management aversion to risk-taking (Osborne and Brown, 2011; Potts, 2009), or professional and management resistance to change. In a study of 125 successful innovations in Britain (NAO, 2006), the most frequently cited barrier to innovation was a reluctance to 'embrace new ways of working'. Other impediments include 'reputational' and 'technological' risk which were frequently cited barriers in a study of successful public sector innovations in the UK, Denmark, Finland

and Estonia (Pärna and von Tunzelmann, 2007). Concerns over political 'embarrassment' or creating an opportunity for opposition party scrutiny and criticism (Koch and Hauknes, 2005; Mulgan and Albury, 2003; Potts and Kastelle, 2010) could result in risk-averse politicians limiting the discretionary freedom of managers to innovate.

2.2. Discretionary innovation support strategies

Under some governance and contextual conditions, agency managers could be able to implement strategies that encourage in-house innovative capabilities, for instance by supporting the trial and error testing of innovations or the evaluation of good ideas suggested by staff (Boyne et al., 2005). Pärna and Tunzelmann (2007) report that 'personal leadership or committed key individuals' was the most important of 13 internal and 12 external factors supporting successful innovation in Denmark and Finland and one of the leading factors in the UK and Estonia. A survey of Scandinavian agencies similarly found that management was the most important of ten drivers for innovation (Bugge et al., 2011).

Techniques such as the use of incentives and evaluation systems to encourage and sift through innovative ideas proposed by staff could improve the likelihood of 'bottom-up' innovation, although the effect of incentives on innovation has varied from no effect in one study (Laegreid et al., 2011) to a positive effect in another (Bysted and Jespersen, 2014).

Managers can also improve innovation by involving users in service design (Kim, 2010) or by scanning activities to identify better ways of doing things that are used by other agencies or businesses, as suggested by Hartley's (2005) concept of lateral innovation. Relevant information can be obtained from sources within government and from external sources, such as professional associations (Damanpour and Schneider, 2006), businesses, and consultants.

There are no data at the agency level on the effect of differences in governance structure on innovation, but research on the sources of ideas for innovations or the initiators of innovations suggests that the majority of public sector innovations in high income countries are proposed by managers and staff and not by politicians acting through legislation or political directives. Borins' (2001) study of innovation award finalists in the United States found that only 20% of the innovations were initiated by politicians versus 82% by middle management and 25% by front-line staff (multiple initiators per innovation are possible). The greater importance of managers and staff compared to political drivers as a source of ideas for innovations has been replicated in innovation surveys in Australia (APSC, 2011; Arundel and Huber, 2013) and Scandinavia (Bloch and Bugge, 2013).

The importance to public sector innovation of scanning external sources for ideas and collaborating with a range of partners has been identified in several studies. A UK study found that two-thirds of local authorities benefited from learning about innovations in use elsewhere (Audit Commission, 2007), while a survey of Australian government workgroups found a positive correlation between the number of idea sources drawn upon for an innovation and the probability of major benefits from the innovation (Torugsa and Arundel, 2015). Pärna and von Tunzelmann's (2007) study of 135 successful public sector innovations found that 'good cooperation with partners' was the second most important factor in supporting successful innovation, after 'personal leadership or committed individuals'. The NAO (2006) survey found that 37.6% of 125 self-reported public sector innovations in Britain included collaboration across agencies. Collaboration with external partners was noted as an important supporting activity in the Scandinavian (Bloch and Bugge, 2013) and Innobarometer surveys (European Commission, 2011). Borins' (2012) research using innovation award finalists found that the rate of cooperation has increased substantially over time, from 29% of 217 finalists between 1990 and 1994 to 84% of 31 finalists between 2008 and 2009.

In summary, the literature suggests that a 'top down' governance structure could be a common innovation method for agencies, particularly in risk-averse environments or where there is staff resistance to change. Bottom-up methods should be relatively common in Northern Europe where work is more likely to be organized around discretionary learning than in Southern Europe and reflect a pro-innovation culture. Newer approaches to innovation such as lateral and networked innovation could also exist. In respect to beneficial outcomes from innovation, it is impossible to predict the types of innovation methods that lead to better outcomes because there has been very little research on this topic. However, the literature provides a few suggestions for what might work, including collaboration (Borins, 2012; Pärna and von Tunzelmann, 2007) and the use of external knowledge sources (Torugsa and Arundel, 2015). The dominance of 'bottom up' innovations proposed by managers and staff among award finalists in the United States (Borins, 2001) suggests that this type of innovation could also be correlated with successful outcomes, although the award data are limited to a non-random selection of innovations and may not be representative of most agencies.

3. Methodology

3.1. Data source

The data for this study are from the 2010 Innobarometer survey of innovation in European Public Administration Agencies. The questionnaire was developed by two of the authors, the European Commission and Gallup Europe. Questionnaire translation into national languages and implementation was managed by Gallup Europe, with the survey in the field in October 2010. Agencies in NACE[1] class 84.11 (general public administrative activities) and NACE class 84.12 (regulation of the activities of providing healthcare, education, cultural services and social services excluding social security) were randomly drawn from business registers. These NACE classes exclude specialized service providers such as educational institutions or hospitals, but include agencies such as ministries of health or education that are responsible for determining how specialized services are provided and funded. As these NACE categories can include private sector and non-profit organizations, a survey question verified that the responding organization was a government organization, with non-governmental organizations excluded from the analyses.

The survey used a quota sample with pre-selected numbers of responses for each country, ranging from ten responses for very small countries (Cyprus, Luxembourg and Malta) to 400 for the larger countries (Germany, UK, France, Italy, Spain and Poland), although the number of realized responses varied from the expected number. In total, the survey obtained 3699 responses from agencies with ten or more employees, of which 3384 (91.5%) reported at least one innovation between January 2008 and the time of the survey.

The target respondent was the agency head. The respondent's area of responsibility can vary significantly, with responses obtained from municipal, regional and national agencies. The European Commission (2011) report provides further methodological details and the survey questionnaire.[2]

[1] The statistical classification of economic activities in the European community, commonly referred to as NACE, is the European industry classification system.

[2] The questionnaire is provided on pages 188–196 of the European Commission (2011) report: http://ec.europa.eu/public_opinion/flash/fl_305_en.pdf.

Table 1
Innovation methods: standardized factor scores for cluster centres and internal validity results.

Factor	1 Bottom-up agencies	2 Knowledge-scanning agencies	3 Policy-dependent agencies	Scheffé analyses: signif. differences between clusters
Barriers	−0.320	0.515	−0.232	1&3, 2&3
External knowledge sourcing	−0.409	0.848	−0.533	1&2, 1&3, 2&3
Policy	−0.172	−0.096	0.306	1&3, 2&3
Active management	0.760	0.031	−0.874	1&2, 1&3, 2&3
Support strategies	0.455	−0.224	−0.254	1&2, 1&3
Inter-rater reliability	0.99	0.98	0.98	
Number of agencies	1,123 (34.3%)	1,156 (35.3%)	994 (30.4%)	

3.2. Variables

The survey queried the characteristics of the agency (country of location, number of employees, function, and geographic area served), three types of innovations (services, communication methods, process/organizational methods), work force skills, and innovation outcomes for service and process/organizational innovations.

All 3384 agencies that reported an innovation were asked four sets of questions on the importance of information sources, policy drivers, strategies and barriers to innovation, measured on a Likert scale. These questions also included a 'don't know/not applicable' response option. If all agencies with at least one 'don't know' response to one of the 25 questions of interest were excluded, 34.8% of innovative agencies would be lost to analysis. To conserve responses, a 'don't know' or 'not applicable' response is assumed to be equivalent to a 'not important' response. The justification is that an important information source, strategy or policy driver is likely to be remembered and relevant. There is one exception to this rule. An agency that replied 'don't know' to all sub-questions in a group (for instance to all eight questions on information sources) is excluded from the analyses because the respondent either refused or was unable to answer any of the relevant questions. In total, 102 agencies (3%) were excluded for this reason, leaving 3282 agencies.

Quantitative outcome measures for agencies are difficult to obtain, as managers are rarely able to provide financial data on the effects of innovations. Consequently, the most common outcome measures for agency surveys are customer (or user) satisfaction or access to services, an increase or decrease in costs, and improvements in quality characteristics (Hughes et al., 2011). The Innobarometer survey asked about the major benefits of innovation on a 'yes' or 'no' basis: one question on five major positive effects of service innovations, one question on four major positive effects of process/organizational innovations, and one question on four major negative effects of any of the three innovation types.

3.3. Analytical methods

We adopt a two-stage analysis. The first stage identifies different approaches to innovation (innovation methods), while the second stage uses regression analysis to determine if the methods are correlated with innovation outcomes.

The first stage follows de Jong and Marsili (2006) and Leiponen and Drejer (2007) by using a three-step exploratory analysis that uses principal component analysis to reduce the number of variables, cluster analysis to assign agencies to discrete clusters on the basis of their factor scores, and validation analysis that uses questions that were not included in the factor analysis to determine if there are other statistically significant differences between the identified clusters.

The number of factors to extract from the principal component analysis was based on Kaiser's criteria, which identified five factors with eigenvalues greater than 1. These five factors explain 48.5% of the variance. All diagnostics are acceptable, with no evidence of multicollinearity problems (no correlations between the variables are over 0.9 and the determinant for all correlations is 0.003, well above the necessary value of 0.00001). The sample size is good with a Kaiser-Meyer-Olkin measure of sampling adequacy of 0.866 for all variables combined and above 0.725 for all individual variables.

As cluster analysis is very sensitive to outliers, nine agencies with at least one factor score with a standard deviation greater than or equal to 3 were excluded, reducing the number of cases to 3273. The cluster analysis uses the K-means cluster procedure suitable for a large numbers of cases. Two-, three- and four-cluster solutions were examined, with the three-cluster solution providing the most interpretable results.

3.3.1. Regressions

Regression models are used to identify agency characteristics that are correlated with each innovation method and to evaluate the relationship between these methods and innovation outcomes. Logit regressions are used for the evaluation of agency characteristics. A multivariate probit model is used for the outcome analyses because the outcomes are correlated with each other, possibly due to the structure of the relevant question, which lists each outcome consecutively. The estimation uses the Geweke–Hajivassiliou–Keane maximum likelihood and simultaneously models the effect of the set of explanatory variables on each of the dependent variables, while controlling for mutual correlations between their error terms. Failing to control for significant correlations can lead to biased estimation of parameters (Amara et al., 2008).

4. Results for the factor and cluster analyses

The principal component analysis identifies five factors: innovation barriers, external knowledge sourcing, policy drivers, active management involvement and innovation support strategies. The best results were for a three-cluster solution for the five factors, as shown in Table 1. The first cluster, labelled 'bottom-up' agencies, has negative scores for the barrier, external knowledge sources and policy factors, but the highest average scores for active management involvement and innovation support strategies, both relevant to the in-house ability of agencies to innovate. The second cluster, 'knowledge-scanning' agencies has high factor scores for external knowledge sources and low or negative scores for policy drivers, active management, and support strategies. Of interest, this is the only cluster with a positive score for barriers, suggesting that these agencies respond to barriers by searching for solutions from external sources. The third cluster, 'policy-dependent' agencies, has the highest score for policy drivers and negative scores for all other factors. The number of agencies per cluster is very similar at approximately one-third each.

Internal cluster validity was examined using a within-group inter-rater reliability test (James et al., 1984) for the degree of

Table 2
Percent of agencies giving a high score to each variable used in the factor analysis.

	Bottom-up	Knowledge-scanning	Policy-dependent	Average
Information sources for innovation (percent 'very important' responses)				
AM Ideas from management	60.8[a]	61.4[a]	21.9	49.2
Ideas from staff	53.9[a]	56.6[a]	21.1	44.9
KS Best practice examples of other governments	34.5	49.4	15.3	33.9
KS Professional organizations	14.6	32.8	4.7	18.0
KS Visits to conferences	12.6	36.1	9.6	20.0
KS Enterprises as suppliers	4.8 [c]	30.0	3.7 [c]	13.4
KS Enterprises as clients	11.4	41.1	5.5	20.1
KS Citizens as clients or users	37.2	70.5	29.2	46.5
Policy drivers for innovation (percent 'very important' responses)				
P Mandated decrease in budget	35.9[a]	38.9[a,b]	42.3[b]	38.9
P Mandated increase in budget	14.1	26.0[b]	27.2[b]	22.3
P New laws or regulations	46.0[a]	50.0[a,b]	53.0[b]	49.6
P New policy priorities	40.5[a]	40.8[a]	36.1	39.3
P Mandated introduction of new e-gov/online services	35.6	50.7	40.6	42.5
Strategies to support innovation (percent 'fully implemented' responses)				
AM Managers support trial and error testing of new ideas	48.7	22.1	2.4	25.3
AM Managers take an active role in innovation	80.4	44.2	14.3	47.5
SS Staff incentives for new idea development	49.9	20.4[b]	17.5[b]	29.6
SS Users involved in design/planning of innovative services	40.0	22.5	14.5	14.5
SS New or improved services evaluated after completion	61.8	45.2	28.6	45.8
Barriers to innovation (percent 'very important' responses)				
B Lack of management support	18.6[c]	47.9	17.7[c]	28.7
B Lack of incentives for your staff	14.7[c]	40.1	17.7[c]	24.6
B Staff resistance	13.4[c]	35.0	12.1[c]	20.6
B Uncertain acceptance by the users of your services	12.5[c]	31.5	11.2[c]	18.8
B Regulatory requirements	30.7[c]	50.5	33.0[c]	38.4
B Lack of sufficient human or financial resources	45.8	63.8	54.2	54.7
B Risk-averse culture in your organization	15.5[c]	29.7	13.2[c]	19.8

Notes: Statistical significance is calculated using X^2 for the full range of categorical responses for each variable. All variables differ significantly across all three methods ($p < 0.001$). The superscripts identify a lack of statistical significance for pairs of innovation methods. The superscript 'a' indicates no significant difference ($p > 0.05$) between bottom-up and knowledge-scanning agencies, 'b' indicates no significant difference between knowledge-scanning and policy-dependent agencies, and 'c' indicates no significant difference between bottom-up and policy-dependent agencies. Otherwise all pairwise differences are significant with $p < 0.001$ with the following exceptions: between bottom-up and policy-dependent agencies for 'visits to conferences' ($p = 0.027$); between external knowledge and policy agencies for 'new policy priorities' ($p = 0.026$), and between bottom-up and policy-dependent agencies for 'new policy priorities' ($p = 0.040$).

agreement within each method for the five factors in Table 1 (Alexy and Reitzig, 2013). MANOVA shows that the three methods differ significantly ($F = 848.9$, $p < 0.001$). Scheffé analyses of the differences by factor by method are given in Table 1. There are significant differences between methods 1 and 3 for all factors, between methods 1 and 2 except for the barriers and policy factors, and between methods 2 and 3 for all factors except for support strategies. The results of the inter-rater reliability test were close to 1 for each cluster, indicating strong within-cluster level of agreement.

Due to space limitations we do not provide a table of the factor loadings. Instead, Table 2 provides the percentage of agencies by cluster that give a high importance rating to each of the 25 questions used in the factor analysis, as this provides a better picture of the differences between clusters.[3] The variables associated with each of the five factors are identified through abbreviations to the left of each variable (AM = active management, KS = knowledge sourcing, P = policy, SS = support strategies, and B = barriers). One of the variables, 'ideas from staff', lacked sufficient variation in the factor loadings to be assigned to any of the five factors, with similar loadings for the external knowledge and active management factors.

As expected, there are statistically significant differences between the three innovation methods for all 25 variables ($p < 0.001$). The highest statistically significant scores are marked in bold. The bottom-up agencies have the highest share of agencies that give a 'high' importance to active management and innovation support strategies. The knowledge-scanning agencies have the highest share of agencies that give a 'high' importance to external knowledge sources and barrier variables. The interpretation is more nuanced for the policy-dependent agencies and explains why this group is labelled 'policy dependent' instead of following Mulgan and Albury (2003) or Hartley (2005) in describing these agencies as 'top down' innovators. With only a few exceptions, the policy-dependent cluster has considerably lower than average shares of agencies that give a 'high' importance to active management, external knowledge, support strategies and barrier variables. However, the shares are only slightly higher than the average for three of the policy variables and slightly below the average for two of the policy variables. The cluster analysis assigns these agencies to the same group because policy variables are the only distinguishing factor for these agencies. The label 'policy dependent' indicates that these agencies are dependent on policy to innovate and largely lack other methods for identifying or developing innovations.

4.1. Differences in internal innovation capabilities

The questionnaire collected data on two agency characteristics that could influence innovation capabilities, but which were not used in the factor analysis: internal activities to support innovation and activities to support information gathering.

The support strategies consist of the share of employees involved in groups that meet regularly to develop innovations and the share of agencies that provide training specifically for implementing, using or providing new or improved innovations. Policy-dependent agencies are more likely to report that none of their employees are involved in groups (30.2% versus 11.1% for knowledge-scanning and 11.8% for bottom-up agencies, $p < 0.000$).

[3] The factor loadings are available from the corresponding author on request.

Table 3
Innovation method by collaboration with external firms and obtaining information from distant sources.

	Bottom-up agencies	Knowledge-scanning agencies	Policy-dependent agencies	Total
Share of agencies that developed innovations through collaboration with external organizations[1]				
Services				
Other public sector organizations	62.7%	67.4%	55.3%	62.5%
Private businesses	42.7%	46.7%	32.3%	41.4%
Not-for-profit organizations	37.8%	41.3%	25.9%	35.9%
Processes/organizational methods				
Other public sector organizations	58.9%	59.9%	43.0%	54.7%
Private businesses	40.8%	42.3%	30.7%	38.4%
Not-for-profit organizations	29.1%	33.5%	19.5%	28.0%
Share of agencies that obtained essential information for innovation from increasingly distant sources[2]				
None (no essential information obtained)	27.9%	25.4%	41.0%	30.6%
Organization in their country	46.9%	44.8%	45.4%	45.7%
Organization in another EU country or outside the EU	25.2%	29.8%	13.6%	25.8%
Total	100.0%	100.0%	100.0%	100.0%

[1] Results limited to agencies that reported each type of innovation. All differences by innovation method in comparison to policy-dependent innovators are statistically significant with $p < 0.05$. The only significant difference between bottom-up innovators and knowledge-scanning innovators is for services for private businesses.
[2] All differences by innovation method in comparison to policy-dependent innovators are statistically significant with $p < 0.000$, but the differences between bottom-up and knowledge-scanning innovators are not statistically significant.

In addition, fewer policy-dependent agencies provide training for innovation: 61.1% of policy-dependent agencies with process/organizational innovations provide training for this type of innovation, versus 76.3% of bottom-up and 78.3% of knowledge-scanning agencies. ($p < 0.001$).

Table 3 provides results for information gathering. The first section gives the share of agencies by innovation method that collaborated on service and process/organizational innovations with three types of collaboration partners. For both types of innovations, knowledge-scanning agencies had the highest and policy-dependent agencies the lowest collaboration rate. The second section of Table 3 gives the percentage of agencies that 'obtained information essential to your innovations' from national sources or from an organization in a different country. The percentages are based on the farthest information source. For example, agencies that obtained essential information from both within and outside their country are assigned to the latter category. We expect knowledge-scanning agencies to be more likely to source essential information from external sources located at a distance. The results show that 29.8% of these agencies obtained essential information from sources located outside their country compared to 25.2% of bottom-up agencies and 13.6% of policy-dependent agencies. Furthermore, 41.0% of policy-dependent agencies did not obtain any essential information from external sources, compared to only 25.4% of knowledge-scanning agencies.

In summary, the external validation results show that there are significant differences between policy-dependent agencies and the other two innovation methods. Policy-dependent agencies have the lowest use of innovation groups, rates of provision of training for innovation, collaboration activities and sourcing information outside their country. However, the differences are much smaller between knowledge-scanning and bottom-up agencies.

5. Contextual factors: agency and national factors

National differences in the prevalence of each innovation method could occur if the public sector replicates observed differences in the organizational structure of private firms, if Hofstede's measures of national culture influence the attitudes of managers and staff to innovation, or if differences in per capita incomes affect the financial resources available to agencies for innovation. In addition, the agency size, function and geographic area of responsibility could also influence the innovation method. All are contextual factors that shape the environment in which innovation occurs.

Preliminary analyses grouped agencies by three European regions: Northern developed countries, Mediterranean countries, and developing and transition countries. In contrast to expectations that policy-dependent methods would be more common in the Mediterranean countries, the share of policy-dependent agencies in each region varied by less than two percentage points from the average of 30.4%.

The national share of each innovation method in 26 European countries for which there were more than 10 respondents was correlated with each of Hofstede's four cultural dimensions and with Kaasa's (2013) combined index for an innovative culture based on high values for individualism and low values for power distance, uncertainty avoidance and masculinity. Kaasa's (2013) data are from the European values study of 2008 and therefore comparable to the time period of 2008 to late 2010 covered by the Innobarometer survey. The shares for 14 European countries were correlated with Arundel et al. (2007) data for the share of employed persons whose jobs displayed the characteristics of a discretionary learning, lean production or Taylorist workplace.

None of the cultural dimensions or workplace organization factors was correlated with the national share of policy-dependent agencies. The most consistent results were for the national share of bottom-up agencies, which was positively correlated with Kaasa's innovation culture index ($R^2 = 0.53$, $p < 0.000$), with the largest effect due to a negative correlation with power distance ($R^2 = 0.37$, $p = 0.002$) and a positive correlation with individualism ($R^2 = 0.41$, $p < 0.000$). The correlations with uncertainty avoidance and masculinity were also negative and significant, but with R^2 values of 0.15 and 0.16, respectively. The correlation between bottom-up agencies and the national share of employees working in discretionary learning organizations was positive and significant ($R^2 = 0.30$, $p = 0.043$) and negative for Taylorism ($R^2 = -0.38$, $p = 0.022$).

The correlations for the share of knowledge-scanning agencies produced lower R^2 values, but they were consistently the opposite sign of those for the share of bottom up agencies. For example, the R^2 for discretionary learning was -0.426 ($p = 0.011$).

Hofstede (2011) noted that two cultural dimensions, individualism and a small power distance, are significantly correlated with per capita GDP. Since these two dimensions are the main factors explaining the correlation between Kaasa's innovation culture index and the national share of bottom-up agencies, we correlated per capita GDP with the cultural index. The correlation coefficient is considerably higher than all others, with

Table 4
Logit regression results for agency characteristics.

	Bottom-up versus policy-dependent agencies	Knowledge-scanning versus policy-dependent agencies	Bottom-up versus knowledge-scanning agencies
Agency employees[1]			
50–99	0.435**	0.450**	0.041
100–249	0.599***	0.523**	0.109
250–499	1.051***	1.378***	−0.204
500–999	0.664**	0.967***	−0.299
1000+	1.191***	1.460***	−0.115
Geo responsibility: national[2]	1.053***	0.559*	0.468**
Geo responsibility: regional[2]	0.343*	0.407**	−0.172
General government agency[3]	−0.291**	−0.085	−0.194*
National average per capita income (PPS)	0.007***	−0.017***	0.020***
Constant	0.341	2.83***	−1.826***
Number of agencies	2117	2136	2270
Nagelkerke R^2	0.115	0.113	0.097
Percent correctly classified	63.0%	64.3%	64.3%

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.
[1] Reference category is 10–49 employees.
[2] Reference category is local agencies.
[3] Reference category is agencies with specific responsibilities only (education, health, housing, environment, etc).

an R^2 of 0.80 ($p < 0.001$). The R^2 coefficient for the correlation between the national share of bottom-up agencies and income is 0.504 ($p < 0.01$), which is very similar to the R^2 of 0.53 for Kaasa's innovation culture index. Conversely, the correlation between income and the share of knowledge-scanning agencies is negative, with an R^2 of −0.285 ($p < 0.005$). There is no relationship between income and the national share of policy-dependent agencies.

These results suggest that cultural or income differences between countries could partly explain differences in how agencies innovate. Since the results are very similar if we use the cultural innovation index or income, we use the latter as a measure of the resources available to agencies to support innovation, but it also serves as a proxy for cultural differences.

How private firms innovate is strongly influenced by their sector of activity (Pavitt, 1984; de Jong and Marsili, 2006). The closest equivalent to a sector for public agencies is their main function. The Innobarometer survey asked respondents if their agency was responsible for seven functional areas, including 'general government activities or finance', education, health, social services, 'culture, sport or recreation', housing, or the environment. Unfortunately, the question asked respondents to select up to three functions, which makes it impossible to identify specific functions. We therefore only differentiate between respondents that cited 'general government activities or finance' and respondents that only cited a specialized function, such as education or health. A significantly higher share ($p < 0.001$) of policy-dependent agencies (66.6%) are responsible for general government activities compared to knowledge-scanning (61.1%) and bottom-up agencies (58.1%).

The majority of agencies serve local areas (73.5% of bottom-up, 77.5% of knowledge-scanning, and 85.4% of policy-dependent agencies) and have fewer than 100 employees (53.9% of bottom-up, 61.1% of knowledge-scanning and 75.6% of policy-dependent agencies).

Table 4 gives regression results for the relationship between contextual factors and innovation methods. Larger agencies are more likely to use bottom-up or knowledge-scanning methods than policy-dependent methods. In addition, agencies that serve national or regional areas are more likely to use bottom-up or knowledge-scanning methods than agencies that serve local areas. An increase in the average per capita income of the country increases the probability that the agency is a bottom-up innovator; whereas, it decreases the probability that the agency is a knowledge-scanning innovator. General function agencies are less likely to use bottom-up methods, while there is no significant difference for this variable between knowledge-scanning and policy-dependent agencies. As shown in the last column, there are no significant differences in the size of bottom-up and knowledge-scanning agencies, but bottom-up agencies are more likely to serve the nation, are less likely to have general government functions, and more likely to have higher national per capita incomes.

6. Results for innovation outputs and outcomes

Given policy interest in improving public sector performance, an important question is if the innovation method is correlated with innovation outputs such as the novelty of innovations and outcomes such as negative and positive effects of service and process/organizational innovations.

For outputs, Table 5 gives results for two novelty measures: if the agency reported a 'country-first' service innovation and if over half of agency services were new or had been significantly improved in the previous two years. The questions were only asked of agencies with service innovations because this type of innovation is publicly visible and therefore respondents are more likely to know how their services compare to those of other agencies. The best performance for both novelty measures is for knowledge-scanning agencies, with the poorest performance for policy-dependent agencies.

For outcomes, respondents were asked if any of their service, process or communication innovations introduced since January 2008 resulted in four types of major negative effects, five major benefits from service innovations, and four major benefits from

Table 5
Innovation novelty by innovation method.[1]

	Bottom-up agencies	Knowledge-scanning agencies	Policy-dependent agencies
Introduced a new service before other agencies in your country	31.9%	36.6%	16.7%
50% or more of services are new or significantly improved since January 2008	11.4%	14.2%	7.3%

[1] Limited to agencies that introduced an innovative service. All differences by innovation method are statistically significant ($p < 0.05$).

Table 6
Percentage of agencies that report positive effects from service and process/organizational innovations introduced in the previous two years.

	Bottom-up agencies	Knowledge-scanning agencies	Policy-dependent agencies
Service innovations[1]			
Offer services to more or new types of users	61.4%	63.8%	*51.2%
Better targeting of services	73.9%	69.7%	*56.6%
Improved user satisfaction	78.5%	76.8%	74.3%
Improved user access to information	82.2%	83.9%	*76.5%
Faster delivery of services	70.5%	71.6%	*58.7%
No positive effect reported	1.3%	1.3%	*4.0%
Process/organizational innovations[2]			
Simplified administrative procedures	71.5%	68.6%	*60.0%
Reduced costs for providing services	58.5%	56.8%	*41.7%
Enable faster delivery of services	69.0%	70.9%	*58.6%
Improved employee satisfaction or working conditions	68.6%	66.3%	*55.1%
No positive effect reported	2.9%	2.7%	*7.7%

*$p < 0.05$.
* = statistically significant ($p <$ compared to bottom-up and knowledge-sourcing agencies.
[1] Limited to agencies that introduced at least one service innovation.
[2] Limited to agencies that introduced at least one process or organizational innovation.

process/organizational innovations. With one exception, there are no significant differences for each of four negative effects, with little difference from the averages of 17.4% reporting major negative effects from 'creating additional administrative costs', 7.1% reporting 'reducing the types or flexibility of your services' and 4.4% reporting 'leading to slower delivery of services'. The exception is a lower percentage of policy-dependent agencies reporting 'user resistance or dissatisfaction' (10.2% versus the average of 13.6%, $p = 0.01$).

Table 6 gives the percentage of agencies that report major positive effects of service innovations and process/organizational innovations. Positive benefits are reported by over 50% of each type of agency. A significantly lower percentage of policy-dependent agencies report positive effects for four of the five outcomes of service innovations and for all four outcomes of process/organizational innovations.

For all three innovation methods, the least commonly cited positive benefit is 'reduced costs for providing services' as a result of process innovations. For instance, only 41.7% of policy-dependent agencies report reduced costs as a positive outcome, compared to 60.0% that report 'simplified administrative procedures'. Since the survey reference period covers 2008 until the end of 2010, therefore including the global financial crisis of 2009, a possible expectation is that government austerity measures might have increased efforts to reduce costs. However, Eurostat (2015) data on general government final consumption expenditures (GFCE), which exclude transfer payments for social welfare, show that total GFCE increased between 2008 and 2010 in the majority of European member states.

Table 7
Multivariate probit results for positive benefits from service innovations.[1]

	Services to more or new users B	Better targeting of services B	Improved user satisfaction B	Improved user access to information B	Faster delivery of services B
Agency employees[2]					
50–99	−0.017	0.082	0.317**	0.206*	0.160
100–249	−0.132	0.025	0.150	0.314**	0.172
250–499	0.138	0.268**	0.146	0.126	0.467***
500–999	0.032	0.316**	0.223	0.510***	0.553***
1000+	0.328**	0.379***	0.277	0.456***	0.713***
Geo responsibility: regional[3]	−0.049	−0.079	−0.081	−0.045	0.012
Geo responsibility: national[3]	0.134	0.008	−0.239**	−0.053	0.111
General government agency[4]	−0.012	−0.038	−0.012	0.047	−0.002
Training for innovation[5]	0.310***	0.452***	0.309***	0.255**	0.389***
Innovation groups[6]	0.166***	0.388***	0.314**	0.171	0.196*
National per capita income[7]	0.005***	0.008***	0.007***	0.004**	0.000
Bottom-up innovator[8]	0.125	0.253***	−0.043	0.030	0.119
Knowledge-scanning innovator[8]	0.274***	0.276***	0.034	0.200**	0.214**
Constant	−0.671	−0.968	−0.339	−0.018	−0.222
Correlation (error terms)					
Better targeting	0.446***				
User satisfaction	0.327***	0.451***			
Information access	0.382***	0.411***	0.389***		
Faster delivery	0.322***	0.485***	0.401***	0.477***	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
[1] Limited to 2416 agencies reporting the introduction of a service innovation.
[2] Reference category is 10–49 employees.
[3] Reference category is local agencies.
[4] Reference category is agencies with specific responsibilities only (education, health, housing, environment, etc).
[5] 50% or more of employees participate in groups that meet regularly to develop new or significantly improved innovations.
[6] Training specifically for implementing, using or providing new or improved services.
[7] Purchasing power standards (PPS) for 2010.
[8] Reference category is policy-dependent innovators.

Table 8
Multivariate probit results for positive benefits from process/organizational innovations.[1]

	Simplify admin procedures B	Reduce costs of providing services B	Faster delivery of services B	Improve employee satisfaction or working conditions B
Agency employees[2]				
50–99	0.017	−0.062	0.157*	−0.069
100–249	0.242**	0.036	−0.005	−0.188*
250–499	0.290**	0.275**	0.192*	−0.071
500–999	0.356**	0.327**	0.342**	−0.019
1000+	0.406***	0.541***	0.285**	−0.178
Geo responsibility: regional[3]	0.054	−0.022	−0.025	−0.027
Geo responsibility: national[3]	−0.036	0.118	−0.031	−0.112
General government agency[4]	0.061	−0.117*	0.146**	−0.091
Training for innovation[5]	0.217***	0.166**	0.309***	0.212***
Innovation groups[6]	0.180*	0.132	0.022	0.226**
National per capita income[7]	0.008***	0.004***	0.001	0.007***
Variety of innovations	0.165***	0.194***	0.227***	0.173***
Bottom-up innovator[8]	0.050	0.170**	0.052	0.173**
Knowledge-scanning innovator[8]	0.062	0.161*	0.078	0.161*
Constant	−1.161	−1.206***	−1.305***	−0.983
Correlation (error terms)				
Reduce costs of providing services	0.349***			
Faster delivery	0.321***	0.317***		
Improve employee satisfaction	0.290***	0.211***	0.271***	

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
[1–8] See Table 7 for notes.

The UK is the only large country which recorded a fall in GFCE over these three years, along with seven smaller economies (Bulgaria, Estonia, Ireland, Latvia, Lithuania, Hungary, and Romania). Austerity did not take hold in other countries such as Italy, Spain, Portugal and Greece until 2011. This might explain why 'reducing costs' was not the most widely cited benefit of process innovation over 2008–2010.

6.1. Regression results for major innovation benefits

Tables 7 and 8 provide regression results for the beneficial effects of service and process/organizational innovation by type of agency while controlling for contextual factors and for two additional innovation support strategies: the provision of training for innovation and if 50% or more of employees are involved in regular group meetings to develop innovations. The reference category for agency type is policy-dependent agencies.

The probability of obtaining at least one positive outcome is likely to increase with the number of innovations. The data lack an innovation count measure, but agency size is included to control for the number of innovations. Another factor is the variety of innovations, with different types of innovations creating different opportunities for specific benefits. Although the questionnaire only asks about service innovations in general, the survey asks about five types of process/organizational innovations.[4] This information is used to construct a variable for innovation variety that equals the sum of 'yes' responses to the five types of process/organizational innovations. Policy-dependent agencies report less variety for their process/organizational innovations: an average of 2.5 types compared to 3.1 for bottom-up and 3.4 for knowledge-scanning agencies.

6.1.1. Control variables

Agency size has a significant positive effect for all five of the benefits from service innovations (see Table 7) and for three of the four benefits from process innovations (see Table 8). The geographic area of responsibility has no effect on reported benefits for both types of innovations, except for 'improved user satisfaction' where national agencies are less likely than local agencies to report this benefit. The agency function has no effect on benefits from service innovations, but general government agencies are less likely than specialized agencies to report reduced costs and more likely to report faster delivery of services for process/organizational innovations.

The use of training and innovation groups is likely to result in innovation benefits by improving efficiency and ensuring that the innovation is a success. As expected, both strategies have a significant positive effect on most of the nine beneficial outcomes.

The average national per capita income (also a proxy for a pro-innovation culture) has a significant positive effect for seven of the nine outcomes, suggesting that higher income and pro-innovation countries are better able to extract benefits from public sector innovation.

Of note, the variable for the variety of process/organizational innovations is statistically significant and positive in all regressions in Table 8.

6.1.2. Innovation method

Both knowledge-scanning and bottom-up agencies are significantly more likely to report positive benefits from innovation than policy-dependent agencies, as shown in Tables 7 and 8. Knowledge-scanning agencies are more likely to report positive results for four of the five benefits of service innovations (the exception is 'improved user satisfaction') and for two of the positive effects from process/organizational innovations ('reduce costs of providing services' and 'improve employee satisfaction or working conditions'). Bottom-up agencies only have an advantage for one benefit from service innovations ('better targeting of services') and for the same two benefits of process/organizational innovation as for knowledge-scanning agencies. As the variables for bottom-up and knowledge-scanning agencies are both measured on a binary scale, their coefficients are directly comparable. The

[4] The five types are new or improved (1) methods of providing services or interacting with your users, (2) improved delivery or logistics systems for your inputs, (3) supporting activities such as maintenance systems, purchasing, accounting or computing systems, (4) management systems, and (5) methods of organizing work responsibilities or decision making.

largest difference between bottom-up and knowledge-scanning agencies is for 'improved user access to information' from service innovations, where the coefficient is not significantly different from zero for bottom-up agencies versus 0.20 and significant for knowledge-scanning agencies. This could be due to the considerably higher share of knowledge-scanning agencies that give high importance to citizens as an information source (70.5% versus 37.2% for bottom-up agencies, see Table 2). This activity could provide knowledge-scanning agencies with better information on user requirements.

7. Discussion and conclusions

This study applied factor and cluster analysis to the results of a 2010 survey of 3273 public sector agencies across 27 EU countries. As observed for the private sector (Pavitt, 1984; de Jong and Marsili, 2006), the results find meaningful differences in how public agencies innovate, with agencies using policy-dependent, bottom-up and knowledge-scanning innovation methods. These categories partly support theoretical research into how public agencies might innovate.

Policy-dependent agencies, accounting for 30.4% of the total, innovate in response to politically mandated changes in the agency budget, new laws or regulations, new policy priorities, or the mandated introduction of new services. This method is in line with traditional perceptions of how a public agency innovates, with decisions taken by elected politicians. Compared to the two other methods, these agencies are less likely to collaborate on the development of an innovation with external organizations or to obtain information for innovation from external sources. Significantly fewer policy-dependent agencies actively encourage staff participation in innovation through work groups to develop innovations or through training to assist with the implementation of innovations. The poor development of in-house innovative capabilities could partly explain why fewer policy-dependent agencies introduced a novel service innovation before other agencies in their country.

Contextual factors could also explain why policy-dependent agencies are less innovative than agencies displaying the characteristics of the other two approaches to innovation. Regression analysis shows that they are significantly smaller than the other two types of agencies and a higher percentage serve local areas versus regional or national areas. These factors could limit the awareness of politicians of relevant innovations that have been implemented by other agencies. However, in contrast to expectations, policy-dependent agencies are not more common in European countries characterized by hierarchical organizational structures in the private sector.

Bottom-up agencies, accounting for 34.3% of the total, have active management support for innovation and have implemented several strategies to encourage the development of innovative ideas. These include incentive programs for staff, support for trial and error testing, and methods to evaluate new services. Bottom-up agencies have several of the characteristics of 'organizational entrepreneurship' described by Moore and Hartley (2008), where managers have the discretionary ability to invest in strategies to support the development of ideas proposed by staff and middle management. They are also the largest agencies in terms of employment and are more likely to serve the national government. Their greater prevalence in the higher income countries of Northern Europe is in line with research that find high rates of innovations proposed by managers and staff in high income countries such as the United States (Borins, 2001), Australia (Arundel and Huber, 2013) and Scandinavia (Bloch and Bugge, 2013).

Knowledge-scanning accounts for 35.3% of the agencies. These agencies seek to overcome innovation barriers by drawing on external sources for good ideas, such as enterprises as clients or suppliers, users of agency services, visits to conferences, professional organizations, and best practice experiences of other governments. Knowledge-scanning agencies use some of the same innovation support methods as bottom-up agencies, although slightly more offer training, collaborate with external organizations, and obtain essential knowledge for their innovative activities from organizations outside their country. The national share of knowledge-scanning agencies is negatively correlated with per capita income, with the highest share in the poorer transition countries of the European Union. The knowledge-scanning agencies exhibit some of the characteristics of Hartley's (2005) concept of lateral innovators.

The analyses do not identify the type of 'networked' agency proposed by Sorensen and Torfing (2012) that draws on both internal resources and external sources for its innovations. As shown in Table 2, considerably fewer bottom-up versus knowledge-scanning agencies give high importance to six external knowledge sources, while considerably more bottom-up agencies have fully-implemented several methods to support innovation. One explanation is the greater importance of barriers such as staff resistance and a lack of resources and management support among knowledge-scanning agencies. This could possibly be due to cultural factors such as lower individualism and higher power distance than for bottom-up agencies, or to lower average per capita incomes resulting in limited financial resources. These problems could force the managers of knowledge-scanning agencies to seek good ideas outside their agency. Yet there is one area of similarity between bottom-up and knowledge-scanning agencies. As shown in Table 3, both bottom-up and knowledge-scanning agencies have similar rates of developing innovations through collaboration with other organizations. This supports the current emphasis in the management literature on the value of innovating through collaboration (Borins, 2012; Christensen and Laegreid, 2007; Hartley, 2005).

The positive correlation between high per capita national incomes and the share of bottom-up agencies and low per capita incomes (predominantly in the transition economies of Europe) and the share of knowledge-scanning agencies suggest another factor that could partly explain the differences between bottom-up and knowledge-scanning agencies. Knowledge-scanning agencies in resource-constrained lower income countries could be imitating, at low cost, the best-practices of more developed countries. In contrast, agencies in high-income countries could be innovating at the frontier of public sector innovations and consequently find fewer good ideas for innovations from external sources, leaving them no choice but to invest resources in developing 'leading edge' innovations. There are parallels here with catch-up strategies in the private sector, where firms in developing countries first innovate through imitation while firms in countries at the technological frontier develop new technology in-house (Furman and Hayes, 2004).

Policy-dependent agencies have the poorest performance for novel service innovations and for beneficial outcomes. Their poorer performance remains after controlling for contextual factors such as agency size, geographic area of responsibility and national average per capita income, and for the use of innovation support strategies such as innovation groups and training. Their consistently poorer outcome performance is unlikely to be due to biases in the responses to the questions on innovation benefits, since there is little difference between the three types of agencies for self-reported negative benefits from service and process/organizational innovations.

The comparatively lower outcome performance of policy-dependent agencies could partly be due to their limited innovative capabilities, but we do not know if this is intentional, for instance

due to a governance system that limits the innovative capacities of these agencies, or a management failure to provide innovation leadership.

Knowledge-scanning agencies are more likely to report positive benefits from service innovations than bottom-up agencies, but there is little difference for process/organizational innovations. The advantage for service innovations could be due to their greater visibility, with knowledge-scanning agencies able to identify and adopt verified best practices in use in other countries.

There are two main results from this study that are relevant to policies to improve public sector innovation. First, a dependence on policy drivers, without other methods of supporting innovation, reduces performance, even after controlling for contextual factors. This is a strong message in support of building the innovative capabilities of public administration agencies. Second, there is more than one method for improving performance, with both a knowledge-scanning and a bottom-up strategy improving performance compared to the policy-dependent method of innovating. Which method is most appropriate depends on the context, with a knowledge-scanning strategy effective in lower income countries with fewer resources and a less developed innovation culture, while a bottom-up strategy could be more appropriate in higher income countries with greater resources and a highly developed innovation culture.

This study has several limitations which point to future research. The data are limited to public administration agencies within Europe and consequently the results could differ for other types of public sector organizations such as schools or hospitals or for non-European countries. Even within public administration agencies, there could be differences by function that could not be examined using the Innobarometer data. Second, this is the first study to attempt to identify different innovation methods among agencies. The results need to be verified using other data sets. Third, the results indicate that agencies tend to either rely on the expertise of managers and staff or rely on the expertise of external stakeholders and users. This provides no evidence in support of Sorensen and Torfing's (2012) vision of a 'networked' agency that innovates using both methods. However, the failure of this study to identify networked agencies could be due to the use of data with a large number of knowledge-scanning agencies from lower income countries, which influences the factor analysis. The application of similar analytical methods to survey data for high income countries such as the United States, Australia or Scandinavia might identify networked agencies. Fourth, research is required to provide deeper insights into drivers that could influence managerial and staff involvement in innovation, such as the effect of salaries, contractual requirements or professional values (Sorensen and Torfing, 2012) in motivating managers and staff to implement methods to improve innovative capabilities and performance.

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References

Alexy, O., Reitzig, M., 2013. Private-collective innovation, competition, and firms' counter intuitive appropriation strategies. Res. Policy 42, 895–913.
Amara, N., Landry, R., Traore, N., 2008. Managing the protection of innovations in knowledge-intensive business services. Res. Policy 37, 1530–1547.
APSC (Australian Public Service Commission), 2011. State of the Service Report: State of the Service Series 2010–2011. Commonwealth of Australia, Canberra.
Arundel, A., Lorenz, E., Lundvall, B.-A., Valeyre, A., 2007. How Europe's economies learn: a comparison of work organization and innovation method for the EU-15. Ind. Corporate Change 16, 1175–1210.
Arundel, A., Huber, D., 2013. From too little to too much innovation? Issues in monitoring innovation in the public sector. Struct. Change Econ. Dyn. 27, 146–149.
Audit Commission, 2007. Seeing the Light: Innovation in Local Public Services. Audit Commission, London.
Bloch, C., Bugge, M.M., 2013. Public sector innovation – from theory to measurement. Struct. Change Econ. Dyn. 27, 133–145.
Borins, S., 2001. Encouraging innovation in the public sector. J. Intellectual Capital 2, 310–319.
Borins, S., 2006. The Challenge of Innovating in Government. IBM Center for Business of Government.
Borins, S., 2012. Making narrative count: a narratological approach to public management innovation. J. Public Admin. Res. Theory 22, 165–189.
Boyne, G.A., 2002. Public and private management: what's the difference? J. Manage. Stud. 39, 97–122.
Boyne, G.A., Gould-Williams, J.S., Law, J., Walker, R.M., 2005. Explaining the adoption of innovation: an empirical analysis of public management reform. Environ. Plann. C: Govt. Policy 23, 419–435.
Bugge, M.M., Mortensen, P.S., Bloch, C., 2011. Measuring Public Innovation in Nordic Countries: Report on the Nordic Pilot Studies. Danish Centre for Studies in Research and Research Policy (CFA), University of Aarhus, Denmark.
Bysted, R., Jespersen, K.R., 2014. Exploring managerial mechanisms that influence innovative work behaviour: comparing private and public employees. Public Manage. Rev. 16, 217–241.
Christensen, T., Laegreid, P., 2007. The whole-of-Government approach to public sector reform. Public Admin. Rev. 67, 1059–1066.
Damanpour, F., Schneider, M., 2006. Phases of the adoption of innovation in organizations: effects of environment, organization and top managers. Br. J. Manage. 17, 215–236.
Dunleavy, P., Margetts, H., Bastow, S., Tinkler, J., 2005. New public management is dead – long live digital governance. J. Public Admin. Res. Theory 16, 467–494.
European Commission, 2011. Innobarometer 2010: Analytical Report Innovation in Public Administration (Flash Eurobarometer 305). DG Enterprise, Brussels.
Eurostat, 2012. Final consumption expenditures of general government at current prices, percent of GDP, and general government gross fixed capital formation for EU-27. (downloaded on 16 January 2012, from epp.eurostat.ec.europa.eu).
Eurostat, 2015. Final consumption expenditures of general government at current prices, 2003 to 2014 (downloaded on 17 April 2015, from ec.europa.eu/eurostat) and FRED data for EU GDP deflators (downloaded on 17 April 2015, from research.stlouisfed.org/fred2/series/NAGIGP01EUA661S).
Furman, J.L., Hayes, R., 2004. Catching up or standing still? National innovative productivity among 'follower' countries, 1978–1999. Res. Policy 33, 1329–1354.
Hartley, J., 2005. Innovation in governance and public services: past and present. Public Money Manage. 25, 27–34.
Hartley, J., Sorensen, J., Torfing, J., 2013. Collaborative innovation: a viable alternative to market competition and organizational entrepreneurship. Public Admin. Rev. 73, 821–830.
Hofstede, G., 2011. Dimensionalizing cultures: the Hofstede model in context. Online Readings Psychol. Culture 2, 1014 dx.doi.org/10.9707/2307-0919.
Hughes, A., Moore, K., Kataria, N., 2011. Innovation in Public Sector Organizations: A Pilot Survey for Measuring Innovation Across the Public Sector. NESTA Index Report, London.
James, L.R., Demaree, R.G., Wolf, G., 1984. Estimating within-group interrater reliability with and without response bias. J. Appl. Psychol. 69, 85–98.
de Jong, J.P.G., Marsili, O., 2006. The fruit flies of innovations: a taxonomy of innovative small firms. Res. Policy 35, 213–229.
Kaasa, A., Vadi, M., 2010. How does culture contribute to innovation? Evidence from European countries. Econ. Innov. New Technol. 19, 583–604.
Kaasa, A., 2013. Culture as a Possible Factor of Innovation: Evidence from the European Union and Neighbouring Countries. SEARCH Working Paper, European Commission, Brussels.
Kim, Y., 2010. Stimulating entrepreneurial practices in the public sector: the roles of organizational characteristics. Admin. Soc. 42, 780–814.
Koch, P., Hauknes, J., 2005. On Innovation in the Public Sector. Publin Report No. D20, NIFU-STEP, Oslo. (downloaded on 3 June 2013, from http://thelearningnetwork.net/Downloads/Library/PUBLIN-publicsectorinnovation.pdf).
Laegreid, P., Rones, P.G., Verhoest, K., 2011. Explaining the innovative culture and activities of state agencies. Org. Stud. 32, 1321–1347.
Leiponen, A., Drejer, I., 2007. What exactly are technological regimes? Intra-industry heterogeneity in the organization of innovation activities. Res. Policy 36, 1221–1238.
Moore, M., Hartley, J., 2008. Innovations in governance. Public Manage. Rev. 10, 3–20.
Mulgan, G., 2007. Ready or Not? Taking Innovation in the Public Sector Seriously. NESTA, London.
Mulgan, G., Albury, D., 2003. Innovation in the Public Sector. Strategy Unit, Cabinet Office, London.
National Accounting Office (NAO), 2006. Achieving Innovation in Central Government Organizations. National Accounting Office, London.

OECD/Eurostat, 2005. Oslo Manual Guidelines for Collecting and Interpreting Innovation Data. OECD, Paris.
Osborne, S.P., Brown, L., 2011. Innovation, public policy and public services delivery in the UK: the word that would be king? Public Admin. 89, 1335–1350.
Pärna, O., von Tunzelmann, N., 2007. Innovation in the Public Sector: Key Features Influencing the Development and Implementation of Technologically Innovative Public Sector Services in the UK, Denmark, Finland and Estonia, 12. Information Polity, pp. 109–125.
Pavitt, K., 1984. Sectoral patterns of technical change – towards a taxonomy and a theory. Res. Policy 13, 343–373.
Potts, J., 2009. The innovation deficit in public services: the curious problem of too much efficiency and not enough waste and failure. Innov.: Manage. Policy Pract. 11, 34–43.
Potts, J., Kastelle, T., 2010. Public sector innovation research: what's next? Innov.: Manage. Policy Pract. 12, 122–137.
Rosenbusch, N., Brinckmann, J., Bausch, A., 2011. Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs. J. Bus. Venturing 26, 441–457.
Sorensen, E., Torfing, T., 2012. Enhancing collaborative innovation in the public sector. Admin. Soc. 43, 842–868.
Steenkamp, J.-B., ter Hofstede, F., Wedel, M., 1999. A cross-national investigation into the individual and national cultural antecedents of consumer innovativeness. Am. Marketing Assoc. 63, 55–69.
Torugsa, A., Arundel, A., 2015. The nature and incidence of workgroup innovation in the Australian public sector: evidence from the Australian 2011 state of the service survey. Aust. J. Public Admin.
Veugelers, R., Cassiman, B., 1999. Make and buy in innovation strategies: evidence from Belgian manufacturing firms. Res. Policy 28, 63–80.
Walker, R.M., 2006. Innovation type and diffusion: an empirical analysis of local government. Public Admin. 84, 311–335.