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Regulatory reform in the era of new technological development: The role of organizational factors in the public sector

Soonae Park

Graduate School of Public Administration, Seoul National University, Seoul, South Korea

Don S. Lee

School of Politics and International Relations, University of Nottingham, Nottingham, UK

Jieun Son

Evaluation Institute of Regional Public Corporation, Seoul, South Korea

Abstract

What is the role of organizational factors in fostering regulatory reform in response to new technological development? Existing studies provide useful frameworks to understand regulatory reform in rapidly changing circumstances but still lack a systematic analysis of how organizational factors affect regulatory reform in the public sector. To fill this gap, we examine the impact of several institutional elements that are central to defining organizational characteristics, such as job tasks, bureaucratic autonomy, and organizational culture. We theorize that regulatory reform is more likely when public sector organizations are more receptive to external changes, which are determined by these characteristics. We leverage original surveys from over 1,000 civil servants in Korea, one of the front runners in new technological development, and find support for our prediction. We find that the implementation of regulatory reforms is more likely when (i) organizational tasks are relevant to scientific and technological development, (ii) higher levels of bureaucratic autonomy are granted, (iii) agency heads demonstrate stronger leadership, and (iv) organizational culture is less authoritarian. Our study makes clear contributions to the literature on public management and regulation theory, and has important implications for regulatory reform in the face of new technological development.

Keywords: new technological development, public sector organizations, regulatory reform.

1. Introduction

What fosters regulatory reform in the public sector in the era of new technological development? The relationship between scientific and technological development and a government's regulatory reform is an important subject, but is not straightforward. As exemplified by the development of railway technology in the 1920s and the U.S. government's initially negative reactions to it (Zuckman *et al.* 1999), the relationship was once perceived as inverse. However, many governments' recent reforms seeking actively to keep pace with the development of information and communication technology (ICT) call the negative view into question. Existing work in the disciplines of science and technology and social sciences inquires into the relationship between regulatory reform and technological innovation (Irwin & Vergragt 1989; Epstein 1994; Blind 2012), and some evidence shows that the government actively implements regulatory reforms to mitigate problems concerning information asymmetry between stakeholders and citizens (Sabel *et al.* 2018). We recognize the existence of the recent phenomenon that scientific and technological development positively affects the government's regulatory reform efforts, and look into the factors that facilitate its implementation in government agencies with the rise of new technologies.

Correspondence: Don S. Lee, School of Politics and International Relations, University of Nottingham, University Park, C-18 Law and Social Sciences building, Nottingham, NG7 2RD, UK. Email: don.lee@nottingham.ac.uk

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Existing studies make theoretical contributions to the literature by developing frameworks of regulatory reform under rapidly changing circumstances (Irwin & Vergragt 1989; Epstein 1994; Boisson de Chazournes 2009; Sabel *et al*. 2018). Given apparent changes in the external environment due to scientific and technological innovations and their substantial effect on society, scholars have discussed the subject from various perspectives, ranging from coevolution between innovation and regulation, law enactment and autonomy, to social consensus, and participation.[1] However, despite the critical role of organizational factors in shaping or constraining administrative behavior, the literature still lacks a systematic analysis of how organizational factors affect regulatory reform in the public sector in this context. To fill this gap in the literature, we examine several institutional components that define organizational characteristics of government agencies, such as job tasks and organizational culture. To explore how these aspects of public sector organizations affect regulatory reform in rapidly changing environments such as new technological development, we focus on the following factors: (i) organizational tasks relevant to scientific and technological development, (ii) bureaucratic autonomy, (iii) public sector leadership, and (iv) organizational culture. We predict that regulatory reforms are more likely to be implemented in conditions where organizations are more receptive to external changes, which are determined by the four factors.

In analyzing the impact of organizational factors on regulatory reform, we leverage surveys of more than 1,000 national civil servants from government agencies in South Korea, one of the front runners in new technological development and one of the highest ranked countries in the world in the E-Government Development Index. By employing the original data of recent surveys of civil servants actively working toward new technological development, we can understand how institutional components that shape organizational characteristics affect a government's regulatory reform efforts in response to changes in the external environment. Our statistical analysis gives strong support to our argument. We find that the implementation of regulatory reforms is more likely when (i) organizational tasks are relevant to scientific and technological development, (ii) higher levels of bureaucratic autonomy are granted, (iii) agency heads demonstrate stronger leadership, and (iv) organizational culture is less authoritarian.

This study makes clear contributions to the literature on public management and regulation theory in the era of new technological development. First, our study makes a theoretical contribution not only by distinguishing public sector agencies dedicated to scientific and technological tasks from other agencies in regulatory reform but also by highlighting central organizational characteristics, such as public leadership and organizational culture, and their impact on regulatory reform. We believe that this is a timely approach in the context of new technological development that has been neglected in past research on the theories of what causes regulatory reform. Second and importantly, our study provides empirical evidence from a technologically developed society that organizational factors do indeed play an important role in regulatory reform in the public sector. Although previous work contributes theoretical frameworks and underpinnings to the literature on regulatory reform (Hahn 2000; May 2005; Helm 2006; Christensen *et al*. 2008), it has clear limitations: whether such models apply and can be generalized to organizations in modern bureaucracies that are surrounded by the rise of new technological development has not been empirically tested. In this regard, our study offers significant policy implications by indicating the nature of organizations that is conducive to regulatory reform in conditions of new technological development.

2. Theoretical background and hypotheses

How to define regulatory reform has been debated in the literature. A broader concept of regulatory reform involves strengthening market competition by minimizing government intervention, assuming that the government and the market are basic principles that make up society (Lindblom 1977, pp. 3–13).[2] On the other hand, a narrower concept of regulatory reform views the essence of regulatory reform as a process of organizational reduction that weakens bureaucratic authority (i.e. regulatory powers) and emphasizes the removal of government restrictions (Mitnick 1980). Yet another view considers regulatory reform as not only the concept of less regulation but also the process of managing regulation better (Baldwin 2005; Wiener 2006). This perspective defines regulatory reform as the *process of selecting an economic and effective means from among numerous policy measures for improvement*. In this study, building on this definition, we argue that regulatory reform in

government agencies requires institutional reform from inside organizations, in order to remove restrictions or enable this process of choosing an economic and effective means.

Regulatory reform itself can be explored from a variety of approaches. For example, one may focus on regulatory compliance among individuals and suggest the aspects related to governance systems, collaboration, and participation as key factors affecting regulatory reform. Alternatively, one can consider regulation as part of public policy and then study the impact of institutional factors on regulatory reform as policy reform (see Bardach & Kagan 2002). According to theories in public policy, those factors selected as central in the implementation of policy reform are clear policy objectives, rational policy content, the characteristics of bureaucracy (e.g. skilled bureaucracy), support from leaders and stakeholders, and a stable policy environment (Sabatier & Mazmanian, 1979). From this discussion, in this article, we consider several organizational factors, such as organizational culture and tasks, to understand their impact on the implementation of regulatory reform.

Examining the influence of institutional aspects of organizational factors, our approach leverages their variation across different agency units, as we see such impact vary across organizations within the whole body of central government. In the next section, as we discuss regulatory reform in the context of new technological development, we first examine whether government agencies dedicated to scientific and technological tasks are more open to regulatory reform. Then, we look further into other organizational factors, namely bureaucratic autonomy, public sector leadership, and organizational culture, to understand their effects on the implementation of regulatory reform.

2.1. Task characteristics and regulatory reform

Regulations are fundamentally characterized as the "intentional intervention of target groups" (Mitnick 1980; Meier 1985; Baldwin & Cave 1999) to achieve policy goals. In order to achieve people's well-being and sustainable economic growth by preventing or resolving various risks, such as financial crisis and environmental disasters, the government designs and implements regulatory policies in many ways, including supervision and deregulation through cooperation with regulated entities. How government agencies respond to situations they face differs according to the nature of their organizational tasks. For example, the emergence of new technologies, such as artificial intelligence (AI),[3] causes multiple different agencies that previously seemed unrelated to each other to work together to address in an interdisciplinary manner new social problems concerning the legal status of robots, as well as corruption and tax evasion involving virtual currencies, and issues of protecting personal information in blockchain medical records. Since uncertainty coming from the development of science and technology results in ripple effects that are hard to predict in advance, the government will implement regulations to limit their potentially negative effects on society as a whole.

Interdisciplinary research in social sciences that studies science and technology inquires whether innovation generated by the rise of new technology conflicts with existing regulations (Irwin & Vergragt 1989; Epstein 1994; Blind 2012; Asquer & Krachkovskaya n.d., forthcoming; Howlett *et al.* n.d., forthcoming; Whitford & Anderson 2019). With increasing uncertainties due to such innovation, the government is often encouraged to actively enforce regulations to mitigate problems concerning the safety of the people, created by information asymmetry between suppliers and consumers (Sabel *et al.* 2018, p. 372). In this regard, science and technology regulations, regardless of their orientation, can be seen as belonging to a general category of regulation policy. Like regulation of other sectors, science and technology regulations have the characteristics of monitoring and punishment based on standard rules, which may restrict the impact of innovation. In particular, the government tries to establish regulations to prevent legitimacy risks caused by innovation,[4] and each government agency tends to use powerful sanctions to ensure that existing regulatory policies strengthen its legitimacy. This point has been noted by past research: according to the external signals model (Olson 1996, pp. 377–378), regulatory bodies attempt to minimize people's negative feedback by sending a signal of strong sanctions to them, because regulatory failures and their negative feedback may undermine regulatory bodies' autonomy and lead to intervention from the legislature or other outside authorities. In addition, new risks arising from scientific and technological development are arguably underestimated, because they are inherently difficult to substantiate, and thus require the application of the "precautionary principle" (Boisson de Chazournes 2009, pp. 191–194). Therefore, active regulatory reform in government agencies is not likely until the risks created by new technologies become fully tangible.

However, despite these restrictions, rapid progress in science and technology can also make a positive impact by changing the conventional industrial structure and the regulatory environment. For example, as multinational companies become more pervasive and countries establish common technology standards among them, the emergence of new communication infrastructures like the Internet makes access to knowledge more convenient and innovation becomes more globalized (Negoita 2014, p. 372). Yet, under these conditions, regulatory environments are too complex and uncertain to control, which requires a different approach. In these circumstances, regulatory agencies that deal with scientific and technological tasks need to contemplate whether to strengthen *ex ante* regulations or reform inappropriate regulations. The rapid development of science and technology makes it difficult to design regulations that uniformly apply to various industries, but regulators still have to identify potential risks and set the standards that companies will abide by.

Of course, accurately predicting future risks and preparing corresponding response systems are daunting tasks even for policy experts in government agencies. However, increasing uncertainty, ironically, may induce regulatory reform by encouraging cooperation between regulators and regulated agents. Facing growing pressures from changes in external environments and needing to address such challenges, regulators handling science and technology policies will need to work with regulated bodies in identifying and containing high risks, which may lead to wide-ranging regulatory reform that covers various sectors in science and technology. For example, mutual cooperation between regulating agencies and regulated bodies, enabling preemptive and proactive activities as well as experimental attempts at technological advancement, has resulted in the implementation of regulatory reform systems, such as RegTech and a regulatory sandbox. Consequently, well-designed regulations promote companies' investment in innovation activities and processes and their launch of innovative products (Porter & van der Linder 1995, pp. 99–100); and the flexible use of regulatory instruments helps to enhance economic welfare and growth (Majumdar & Marcus 2001, p. 171). In sum, from this discussion, we predict that government agencies related to science and technology policies will more actively carry out regulatory reform than other agencies.

Hypothesis 1. Agencies that handle science and technology policies are more likely to implement regulatory reform than other agencies.

2.2. Bureaucratic autonomy and regulatory reform

Can the bureaucracy be autonomous; and is it desirable for the bureaucracy to be autonomous? These questions have been debated for a long time. While the Madisonians make it clear that bureaucratic latitude should not be recognized under strict legalism (Lowi 1979), the Hamiltonians point out that bureaucratic latitude is necessary for an effective and practically functioning government (Goodsell 1981, 1985). In general, bureaucratic autonomy can be understood through two different approaches. First, from the principal-agent framework, bureaucratic autonomy means the extent to which government agencies may implement policies that deviate from a higher institution's preference. In this view, bureaucratic autonomy concerns agencies' decision-making abilities in implementation (Meier 1980, 1985; Hammond & Knott 1996, 1999; Verhoest *et al.* 2004; Verschuere 2007). Second, bureaucratic autonomy not only means managerial autonomy related to institutional operations, such as human resource and financial management but also includes policy autonomy that allows for agents' selection of appropriate policy measures (Roness *et al.* 2008, p. 161; Ege 2017).

Then, what is the expected relationship between bureaucratic autonomy and regulatory reform? In the past, efficient organizations were perceived to meet the two conditions – (i) highly integrated, hierarchical structures and command systems and (ii) strict rules and procedures to regulate organizations.[5] However, this perception is only valid in simple and stable environments, where organizations are able to respond quickly to environmental changes (Roness *et al.* 2008, p. 158). When policy environments are more complex and changing rapidly, as in the case of the development of technology, processes within organizations must have sufficient discretion and autonomy for the bureaucracy to respond to these external changes (Roness *et al.* 2008). A strictly controlled organization rather has (i) low authority to respond flexibly to environmental changes and (ii) a large amount of information funneled toward the organization's decision-makers, such that information overload will instead delay the decision-making (Roness *et al.* 2008, p. 158). Inversely, an organization with high discretion and

flexibility will be able to respond adequately to environmental changes, in order to select the best decision-making process and policy measures and to attain the organizational goals and policy objectives.

Therefore, greater bureaucratic autonomy results in a greater possibility of improving regulations that do not match the environmental changes. In improving through the implementation of regulatory reform, both official and unofficial procedures are involved. Often, public organizations prepare standard operation procedures (SOPs) or manuals for this reform, but discretion is more likely to occur at the actual implementation stage. Particularly in the field of science and technology that experiences rapid changes, excessive formalization in the politico-economic regulatory environment rather hampers flexible operations and timely responses to external changes; on the other hand, unofficial administrative activities, which are flexibly applied according to situations and the characteristics of targets, help more easily to obtain compliance from the regulated entities. In brief, we expect that, in the conditions where bureaucratic autonomy is greater and agencies have more room for informal operations, regulatory reform will more actively occur.

Hypothesis 2. Agencies that are more autonomous are more likely to implement regulatory reform than less autonomous agencies.

2.3. Public leadership and regulatory reform

Leadership is presented as a key factor of organizational management in numerous studies and as a success factor in achieving policy goals (Pressman & Wildavsky 1984; Meier 1985; Rainey & Steinbauer 1999; Choudhary *et al.* 2013; Subramony *et al.* 2018). Studies related to regulatory reform also consider leadership to be a critical factor (OECD 1998; Christensen *et al.* 2008). While regulatory reform may be carried out according to the convictions or goals of top-level policy makers, most regulatory reform in the field of science and technology occurs due to innovation from technological development and the need for a new regulatory environment. Leadership plays a pivotal role in handling the latter situations: not all innovation leads to regulatory reform, and leaders consider what and how to reform carefully in a given sociopolitical context (van Buuren & Loorback 2009, p. 382). Moreover, since regulatory reform processes may provoke strong opposition from various stakeholders, as they can reduce the "increasing returns" that companies and interest groups in the system have enjoyed and further change the regime's income redistribution (North 1990, p. 99), leadership should be one of the most important factors in handling the implementation of regulatory reform (OECD 1998). Specifically in science and technology policy sectors, public organizations often encounter difficulties in predicting the degree and direction of technological changes; it is the leaders' role that matters in making decisions that can optimize problem-solving and in establishing a necessary policy in advance. With insufficient information and bounded rationality under rapidly changing circumstances, leaders' ability to simplify complex situations through focusing on the most important issues, and their problem-solving, is what every organization needs (Cyert & March 1963; Simon 1978).

The innovative behavior of leaders – that is much needed in the dynamic environments surrounding the science and technology sectors – can be clearly described through the ambidextrous leadership theory. This leadership theory emphasizes a leader's capacity to utilize existing knowledge and tools for successful organizational or institutional reform and to effectively explore alternative solutions for the future.[6] Existing studies also find that ambidextrous leadership facilitates innovative actions in the organization (Rosing *et al.* 2011; Zacher & Wilden 2014; Zacher & Rosing 2015). At the core of ambidextrous leadership theory is the ability to perform various leadership roles according to internal and external needs, since various tensions and contradictions may appear in the process of innovating within the organization in response to complex external environments. With regard to regulatory reform, the innovative behavior of a leader can be regarded as a series of processes to create, select, and implement advanced technology and appropriate systems for the proliferation of new technology (Scott & Bruce 1994). For successful regulatory reform in response to the development of new technologies, therefore, the manifestation of such leadership behavior is necessary. This discussion leads to our third hypothesis:

Hypothesis 3. The stronger agency heads' leadership is, the more actively regulatory reform will take place in the agencies.

2.4. Organizational culture and regulatory reform

Administrative style, which is a collection of institutionalized patterns regarding the politics-administration relationship, norms, and procedures established over a long period of time (Howlett 2004, p. 15), attracts much attention as a factor affecting the performance of administrative reform (Knill 1999). It is closely related to organizational culture as they play a similar role in organizational context.[7] As a source of the behavior of organizational constituents that covers shared values, beliefs, norms, and consciousness, organizational culture becomes its control system when policy makers explore possible alternatives and choose policy tools (Deal & Kennedy 1983). The question is, what aspects of organizational culture stimulate or discourage administrative reform efforts in the organization?

According to research on the forms of organizational culture (Allaire & Firsirotu 1984; Denison & Spreitzer 1991; Denison & Mishra 1995; van van Muijen & Turnipseed 1999; Hogan & Coote 2014), external constraints posed by organizational culture can be classified into (i) individual constraints that determine each constituent's behavior and (ii) structural constraints that determine the behavior of individual constituents or that of organizations. The former is divided further into individualism and collectivism, whereas the latter can be split into authoritarianism and democracy. For the sake of our discussion, we extend the latter point, particularly on authoritarian culture.

Authoritarian culture emphasizes organizational control and internal orientation, and this type of culture exhibits the characteristics of norms and values related to bureaucratism. It is also closely related to the hierarchical structure of authority within organizations: the more hierarchical the structure is, the larger the vertical authority gaps between individuals or sub-units (Fry 1982). Authoritarian culture has the characteristics of rigid attitudes among employees and nonparticipatory policy decision-making (Hofstede 1984). Consequently, bureaucrats in authoritarian organizational culture may behave passively, show a psychological sense of helplessness, and exhibit self-centered and opportunistic attitudes toward given tasks.

Organizational constituents who feel alienated from authoritarian culture also express low satisfaction and show negative behavior, such as rejecting participation in change, delaying work, and increasing resistance (Ashforth & Lee 1990; Coghlan 1993; Ford 1996). When organizational constituents become discontented with their organizational culture, a desire for defense arises naturally in response to the losses that they suffer due to changes (Coghlan 1993; Ford 1996). Defensive behavioral patterns take the forms of immobility and avoidance of blame (Ashforth & Lee 1990), which negatively affect the organization, and they become one of the most significant causes of decreased effectiveness when the organization needs regulatory reform: it is difficult to motivate constituents with a strong avoidance disposition which dampens expectations for any change in organizational behavior or achievements. In addition, bureaucrats' tendency to protect their domain concerning regulatory changes or their resistance to change itself (i.e. the "Regulatory Ratchet") can also be considered as a defensive psychological constraint (Bardach & Kagan 2002). Therefore, our last hypothesis is:

Hypothesis 4. More authoritarian organizational culture will lead to less implementation of regulatory reform.

3. Survey design and data

In order to test our hypotheses, we constructed an original dataset through a national civil servant survey conducted in South Korea between 2016 and 2017. South Korea is a particularly interesting case for studying regulatory reform in the context of new technological development, not only because its government is ranked as one of the highest in the E-Government Development Index but also because its civil service corps is ranked as one of the most effective globally (Lee 2018; Lee 2020; Lee & Schuler 2020).[8] The recruitment and promotion of its

civil servants are merit-based, whereby most of them enter the civil service through competitive centralized examinations at grades 9, 7, and 5 (low-high), respectively, and they are promoted through a rule-bound system.

Our survey data come from 29 central government agencies, and the sampled agencies are representative of South Korean national agencies in terms of demographics (see Table A1 for the list of government agencies included in our study). Our surveys were administered by Hankook Research, one of the largest survey research firms in South Korea.[9] The surveys were distributed to civil servants based on a stratified sampling method to ensure that respondents across agencies represented a similar mix of civil service ranks, recruitment type, and gender. The sampling method also aimed to obtain a certain number of respondents proportional to the size of each agency unit. The surveys were assigned to civil servant respondents at their workplace and completed in private. No personally identifying information was obtained.[10]

In total, 1,010 surveys were completed, and the nonresponse rate of our survey was less than 10%. Table 1 shows the characteristics of the respondents: an education level of 0 = completion of community college (or lower), 1 = completion of college (4-year program), and 2 = completion of graduate school (MA or PhD); a civil service rank of 0 = grade 9 (lowest), 1 = grade 8, 2 = grade 7, 3 = grade 6, 4 = grade 5, 5 = grade 4, and 6 = senior civil servant (highest); a civil service job category of 0 = technical and 1 = administrative; and a recruitment type of 0 = open recruitment and 1 = centralized civil service examination. Figure A1 graphically shows the distribution of respondents by each of these characteristics.

Of the 1,010 completed surveys, 760 (75.2%) of the respondents are 47 years old or younger, 326 (32.3%) are female, 733 (72.6%) hold a BA (4-year program) or a higher degree, 863 (85.4%) are from grade 5 or lower, and 734 (72.7%) have no private sector experience before entering the civil service. Table 1 also presents the descriptive statistics of our variables introduced below.

4. Statistical modeling and empirical findings

In this section, to test our hypotheses through statistical analysis of our original survey data, we first introduce our dependent, independent, and control variables. The main dependent variable, *regulatory reform*, is a measure of the likelihood of implementing regulatory reform at the organizational level. The dichotomous variable is a civil servant's response to the following survey question: "Has your organization implemented any regulatory

Table 1 Characteristics of civil servant respondents and descriptive statistics of variables

	Mean	Std. dev.	Min	Max
Characteristics				
Age (years)	40.54	8.23	19	59
Female (%)	0.32	0.47	0	1
Education	0.78	0.53	0	2
Civil service rank	3.36	1.18	0	6
Civil service job category	0.73	0.45	0	1
Recruitment type	0.81	0.39	0	1
Private sector experience (years)	1.18	2.92	0	30
Professionalism	3.27	0.83	1	5
Dependent variable				
Regulatory reform	0.361	0.481	0	1
Independent variable				
Science and technology sector	0.458	0.498	0	1
Bureaucratic autonomy	3.192	0.809	1	5
Agency head leadership	−0.092	0.930	−2.430	1.661
Authoritarian culture	−0.002	0.885	−3.614	1.755
Control variable				
Staff size (log)	7.608	1.245	5.513	10.404
Budget size (log)	10.230	2.107	5.746	13.233
Agency head's political ideology	0.110	0.314	0	1

reform in the last three years?" In the survey, this question was detailed with a clear definition of the implementation of regulatory reform as "choosing an economic and effective means – either new or updated – from among numerous policy measures for improvement of the agency's regulatory function" (Baldwin 2005; Wiener 2006).

We have four key independent variables for each of our hypotheses. First, as a measure of the *science & technology sector*, we use a dichotomous variable that classifies whether civil servants are from agencies related to new technological development and actually handle science and technology policies. Following the *2016 Guideline of Performance Management and Evaluation in Public Services* issued by the Office for Government Policy Coordination under the Office of the Prime Minister in South Korea,[11] we classify the 11 agencies listed in Table 2 into the science and technology policy sector group.

Second, *bureaucratic autonomy* is the level of discretion that civil servants can enjoy in policy implementation in a given organization. To estimate this measure, we use civil servants' answers to the following question: "High levels of autonomy are granted in implementing policies in your organization." The answer is recorded on a five-point scale, ranging from "strongly agree" (5) to "strongly disagree" (1).

Third, *agency head leadership* is a measure of civil servants' assessment of their agency heads' leadership in three dimensions: policy expertise, organizational management abilities, and skills in coordination with other branches. We construct the measure from answers to three questions on each of the three dimensions on a five-point scale by developing a measurement model, where a general approach of factor analysis is adopted to generate a continuous variable. Higher values on this measure indicate higher levels of leadership capacity. Table 3 displays the path coefficients and means in the measurement model. We test the correlation between the single questions and the construct, which falls between 0.587 and 0.946. In brief, the scale properties of our construct show acceptable validity and reliability.

Fourth, *authoritarian culture* measures the degree of authoritarianism in the civil service organizations' culture. We construct the measure from answers to two questions that capture two main features of authoritarian culture: (i) whether organizations are hierarchically structured so that norms and values related to bureaucratism are perceived as important; and (ii) whether organizations regularly monitor and control their employees (Fry 1982).[12] They were asked both on a five-point scale, ranging from "strongly disagree" (1) to "strongly agree" (5). Higher values on this measure indicate higher degrees of authoritarianism. Table 4 displays the path coefficients and means in the measurement model. We test the correlation between the single questions and the

Table 2 Eleven agencies in the science and technology policy sector

Agency	Relevance
Ministry of Science and Technology	Main policy area
Ministry of Education	Science and technology education
Ministry of Agriculture, Food and Rural Affairs	Fourth industrial revolution area (biological section)
Ministry of Trade, Industry, and Energy	Fourth industrial revolution area (physical section)
Ministry of Health and Welfare	Biotechnology
Ministry of Environment	Nanotechnology
Ministry of Oceans and Fisheries	Biotechnology
Public Procurement Service	Autonomous vehicles and other equipment
Small and Medium Business Administration	Fourth industrial revolution area (physical section)
Korea Fair Trade Commission	Fourth industrial revolution area
Financial Services Commission	Fourth industrial revolution area

Office for Government Policy Coordination under the Office of the Prime Minister.

Table 3 Survey items for the leadership construct and its measurement model

Item	Path coefficient	Mean
Policy expertise	0.880	3.41
Organizational management abilities	0.729	3.32
Skills in coordination with other branches	0.805	3.45

Table 4 Survey items for the authoritarianism construct and its measurement model

Item	Path coefficient	Mean
Hierarchical structure and norms and values related to bureaucratism	0.802	3.78
Regularly monitoring and controlling employees	0.801	3.61

construct, which falls between 0.643 and 0.906. Therefore, the scale properties of our construct display acceptable validity and reliability.

In addition, we control for eight individual and three organizational factors that may affect the likelihood of an agency's implementation of regulatory reform. Besides the seven demographic and civil service characteristics of the respondents described above, we control for bureaucrats' professionalism. Since the effect of bureaucratic autonomy may be conditional on the underlying preferences of bureaucrats in implementation (Teodoro, 2011; Miller & Whitford, 2016), we include in our models civil servant respondents' answer to the question "I know what I am expected to do in my organization." The question was asked on a five-point scale, ranging from "strongly agree" (5) to "strongly disagree" (1).

Further, we also include three organizational variables: the size of the budget and staff in a given agency and the political ideology of agency heads. The size of the budget and staff can affect the agency's capacity to implement policy reform. Our budget and staff data come from the National Assembly Budget Office and the Ministry of Personnel Management, respectively.[13] Regarding the political ideology of agency heads (1 if agency heads are from the ruling party, and 0 otherwise), we control for this variable, as the effect of their leadership can be conditional on their ideology or their relationship with lawmakers (Weingast & Moran 1983; Meier 1985; Lee & Park 2020).

5. Results

Table 5 presents the results of our analysis. Models 1 and 2 test the proposed hypotheses with control variables only included in Model 2. The results lend strong support to our hypotheses by confirming the predicted relationships between the implementation of regulatory reform and each of the four independent variables concerning organizational characteristics. To estimate the likelihood of implementation of regulatory reform, given that our dependent variable is dichotomous, we use logistic regression models with robust standard errors clustered on each agency. All our models include agency fixed effects. Specific results are discussed below.

First, the coefficient of the *science & technology sector* is positive and statistically significant. Based on the estimation of Model 2, agencies related to new technological development are more likely to conduct regulatory reforms by 14.3 percentage points, holding all other variables constant at their means. The substantive effect is graphically shown in Figure 1. This finding confirms our first hypothesis, suggesting that agencies that handle science and technology policies are indeed more likely to implement regulatory reform than other agencies in the context of new technological development.

While such development facilitates access to knowledge and innovations in the public sector (Negoita 2014), agencies that closely handle science and technology issues are more keen to make regulatory reform efforts, for practical reasons. Consider the creation of the New Industry Regulatory Innovation Committee in South Korea. When President Moon Jae-in took office in May 2017, one of his primary policy initiatives was to push for regulatory reform in new industry sectors needed for economic development, such as ICT fusion, energy and new materials, and bio-health.[14] We find that such industries largely overlap the science and technology policy areas listed in Table 2.

Second, the coefficient of *bureaucratic autonomy* is positive and statistically significant. Based on the estimation of Model 2, organizations with highest observed levels of autonomy are more likely to implement regulatory reform than those with lowest observed levels of autonomy by 11 percentage points. We graphically present its substantive effect in Figure 1. This finding confirms our second hypothesis. Consistent with previous research, we find that bureaucratic organizations with more autonomy tend to respond more actively to external

Table 5 Logistic analysis: estimations of regulatory reform

	Model 1		Model 2	
	Est.	SE	Est.	SE
Independent variable				
Science and technology sector	1.802***	(0.026)	1.516***	(0.072)
Bureaucratic autonomy	0.209**	(0.095)	0.199**	(0.097)
Agency head leadership	0.147*	(0.077)	0.158*	(0.080)
Authoritarian culture	−0.634***	(0.092)	−0.554***	(0.097)
Control variable				
Age			−0.013	(0.012)
Female			−0.356*	(0.192)
Education			0.144	(0.141)
Civil service rank			0.367***	(0.114)
Civil service job category			0.293	(0.185)
Recruitment type			0.440	(0.321)
Private sector experience			0.044	(0.031)
Professionalism			0.216*	(0.111)
Staff size (log)			−0.793***	(0.143)
Budget size (log)			0.285***	(0.072)
Political ideology			−1.530***	(0.489)
Constant	−0.930***	0.143	−0.093	(0.857)
N	1,010		1,010	

***$P < 0.01$, **$P < 0.05$, *$P < 0.1$.

Robust standard errors are in parentheses. All models include agency fixed effects.

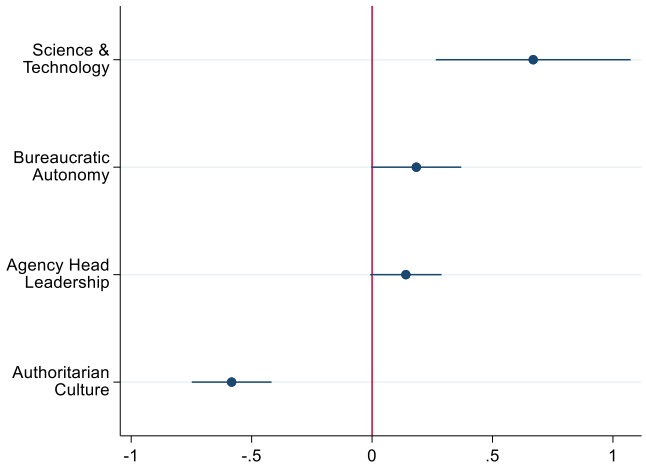

Figure 1 Estimated effects of the four independent variables on the likelihood of implementation of regulatory reform. Estimations are based on Model 2 in Table 5, and control variables are not presented. Ninety-five percent confidence intervals are shown.

environmental changes, such as new technological development, and suspect that this effect is mainly due to their flexibility and decentralized decision-making structure (Roness *et al.* 2008).

Third, the coefficient of *agency head leadership* is also positive and statistically significant in Table 5. Based on the estimation of Model 2, an increase in *agency head leadership* from its observed minimum to maximum values leads to an increased likelihood of implementing regulatory reform by 11.8 percentage points, holding all others constant. we visualize its substantive effect in Figure 1. Overall, this finding confirms our third hypothesis. Consistent with past work on the role of leadership in regulatory reform under conditions of technological innovation (Zacher & Wilden 2014; Zacher & Rosing 2015), this finding suggests that leadership indeed plays a

central role in inducing innovative actions in such organization. Consider Oh Myung, the former Minister of Science and Technology in South Korea, as a case where reform initiatives by leaders who are experts in the field can lead to high performance in public sector agencies. During Oh's tenure as a science and technology minister, his reform initiatives drew substantial support from major electronics companies, including Samsung and LG, and thanks to his leadership, the ministry successfully carried out necessary regulatory reforms.[15]

Finally, the coefficient of *authoritarian culture* is negative and statistically significant. Based on the estimation of Model 2, organizations with most authoritarian culture are less likely to implement regulatory reform than those with least authoritarian culture by 52 percentage points. Its substantive effect is clearly shown in Figure 1. Therefore, this finding confirms our fourth hypothesis. Indeed, organizational culture does affect agencies' regulatory reform efforts (Knill 1999) and is likely to shape how organizations respond to important changes in external settings, such as new technological development. Authoritarian organizational culture means more centralized control and less flexibility in policy implementation. Consequently, as expected, facing new technological development, regulatory reform is less likely to be implemented in organizations with a more hierarchical and rigid culture.

Some of our control variables attain statistical significance. It is notable that both higher civil service ranks and higher levels of bureaucrats' professionalism are positively associated with the likelihood of implementing regulatory reform. The finding about bureaucrats' professionalism is particularly in line with past work on civil servants' professionalism (Miller & Whiford, 2016; Lee & Park n.d., forthcoming). We also find that organizations' budget size helps implementation of regulatory reform, but their staff size has a negative impact on regulatory reform. We believe that, while organizational financial capacity has a positive impact on regulatory reform, too big a staff size may hamper such reform. In addition, we find the significant but negative effect of agency heads' political ideology (i.e. belonging to the conservative ruling party) on regulatory reform. While this finding itself is interesting, it requires further investigation to distinguish whether the effect comes from their ideology or their relationship with the ruling party.

6. Conclusion

In this study, we aimed to broaden our understanding of the factors that foster regulatory reform in the era of new technological development by focusing on the role of organizational factors in the public sector. Specifically, we examine the institutional aspects of public sector organizations that are central to defining organizational characteristics, such as task characteristics, bureaucratic autonomy, public sector leadership, and organizational culture. We test whether regulatory reform is more likely to be implemented in conditions where organizational features are more receptive to external environmental changes, which, we argue, is determined by a set of these organizational factors. We analyze original survey data from more than 1,000 national civil servants in South Korea, one of the front runners in new technological development. Our analysis strongly supports our predictions: regulatory reform is more likely to be implemented when (i) organizations' tasks are closely related to science and technology policies and new technological development, (ii) higher levels of discretion are granted in policy implementation, (iii) agency heads demonstrate stronger leadership capacity, and (iv) organizational culture is less authoritarian.

Our study makes clear contributions to the literature on public management and regulation theory, and has important implications for regulatory reform in response to new technological development. Given the central role of institutions in rapidly changing environments, our analysis shows clear evidence that institutional elements, such as bureaucratic autonomy and organizational culture, play no less important a role in facilitating or hindering regulatory reform in the face of critical external changes. While future studies should aim to continue studying other important but less examined organizational characteristics, such as public service integrity and shared missions, our study takes a meaningful step toward surveying the role of organizational factors in regulatory reform under conditions of new technological development.

Although our study contributes to the literature by empirically testing with original data the theories and models from past work on regulatory reform, it is not without limitations. Our measure of the implementation of regulatory reform relies on the perception of national civil servants in South Korea. South Korea's bureaucrats are from highly professionalized systems: they are recruited through competitive examination and trained and

promoted by merit-based rules. Therefore, their assessment of policy implementation for which they are directly responsible should have much higher validity and reliability than assessment from the perspective of citizens (Andrews *et al.* 2006). Still, human memory and knowledge themselves are imperfect. Therefore, further research on this subject needs to be conducted with an analysis of data from objective indexes recording the frequency of the regulatory reforms implemented in each agency, in order to complement the findings of this study.

There are a number of areas where future research can seek to help our understanding of regulatory reform in new technological development. One area is the development of a more unifying theoretical framework that would underpin the role of organizational factors in explaining the implementation of regulatory reform. In this study, we proposed and tested the impact of several organizational factors by putting together various disparate concepts from the literature on regulation theories. Yet, what the overarching framework forming the basis of these factors may be, and how these factors cooperate in facilitating the implementation of regulatory reform, are still largely unknown. The results from our additional statistical analysis in Table A2 suggest that each of the four organizational factors discussed in this study seems sufficient to induce regulatory reform without others being present concurrently.[16] In addition, some of the variables used simply as controls in our analysis, such as bureaucrats' professionalism, need further investigation in future research on regulatory reform in new technological development. In this study, we mainly focused on organizational behavior in explaining each agency's response to new technological development, but as recent studies show (Teodoro, 2011; Miller & Whitford, 2016), the behavior of individual bureaucrats related to their professionalism and ambition should not be less important for successful implementation of regulatory reforms, particularly in rapidly changing external circumstances.

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Endnotes

1 For example, Irwin and Vergragt (1989) suggest social and institutional negotiations as a useful approach and discuss the specific characteristics and relationships of regulation and innovation. Boisson de Chazournes (2009) stresses the need for a precautionary principle and participation under external changes.

2 According to this broader concept, regulatory reform does not simply mean removing government intervention, but also emphasizes appropriate functional harmony between the government and the market imposing on firms' social responsibility concerning environmental pollution, healthcare, and public safety (Mitnick 1980, p. 418).

3 Such technology combines biotechnology, brain engineering, and computer technology; virtual currency; and healthcare using blockchain technology.

4 Legitimacy is "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman 1995, p. 571). Legitimacy in regulation policies can be a perception that regulations (or regulatory reforms) are desirable; that is, a belief that the original purpose of the government is to safeguard people from unexpected danger through regulations (reform). The legitimacy of an organization or that of a policy strengthens the stability and cohesion of the organization and is essential for the acquisition of organizational resources such as budgets, labor, and outside monitoring. It is important for organizations to secure legitimacy (Suchman 1995. pp. 574–575), because illegitimacy leaves them vulnerable to claims that they are negligent, irrational, or unnecessary (Suchman 1995, p. 575).

5 The main purpose of these regulations was to ensure fairness to citizens and to discourage discriminatory policies.

6 According to this theory, interaction between opening and closing leader behaviors is a key driver of successful reform: opening behavior encourages organizational constituents to work in diverse circumstances and practice exploration activities to try out new ideas, whereas closing behavior presents clear standards and work regulations to organizational constituents, and promotes management activities such as the establishment of work procedures and performance monitoring.

[7] Administrative style includes the relationship between the government and the internal norms and procedures of the organization. Although administrative style and organizational culture are conceptually not the same, they both become external constraints to organizational constituents. Since we discuss their role mainly in relation to organizational context, we will use them interchangeably.

[8] In 2018, South Korea was ranked third in the E-Government Development Index and first in the E–Participation Index (https://www.un.org/development/desa/publications/2018-un-e-government-survey.html, accessed 10 September 2019).

[9] https://www.hrc.co.kr/eng/. Survey samples collected by Hankook Research have been widely used in social science research.

[10] The human research subjects aspect of our research protocol was approved by our university's Institutional Review Board.

[11] http://www.evaluation.go.kr/mobile/user/mobileBoardDetail.do?boardCode=psec_eva&boardSeq=220 (last accessed 2 April 2019).

[12] A continuous variable is created based on our measurement model, which adopts a general approach of factor analysis.

[13] Sources: http://www.openfiscaldata.go.kr/portal/service/mainFinanceStat1Page.do (budget); http://www.mpm.go.kr/mpm/lawStat/infoStatistics/hrStatistics/statisticsAnnual/?boardId=bbs_0000000000000037&mode=view&cntId=853&category=&pageIdx= (staff) (accessed 5 April 2019).

[14] http://biz.chosun.com/site/data/html_dir/2018/01/22/2018012201120.html (accessed April 10, 2019).

[15] http://www.2000news.com/news/articleView.html?idxno=11949 (accessed 14 April 2019).

[16] In Appendix Table A2, we re-run the analysis with each of our four independent variables in separate models, controlling for the same individual and organizational variables included in our original Model 2 of Table 5. We find that the four independent variables in four different models are statistically significant and conform to our predicted directions.

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Appendix S1. Supporting Information.

