Policy Research Working Paper 9445

Political Dividends of Digital Participatory Governance

Evidence from Moscow Pothole Management

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WORLD BANK GROUP
Development Economics
Development Research Group
October 2020

Policy Research Working Paper 9445

Abstract

This study takes advantage of a publicly salient policy sphere—road quality—in the Russian Federation's capital city to explore the use of digital technologies as means of aggregating information and demonstrating government capacity and effectiveness. It focuses on the potential linkage between road quality based on citizens' complaints and electoral outcomes in two rounds of Moscow mayoral elections in 2013 and 2018. The data on more than 200,000 online potholes' complaints were collected and combined with local election data. The causal relationship between these two processes is established, making use of an arguably exogenous variation in the differences across local weather conditions during the heating season that differentially affects pothole creation but is uncorrelated with electoral outcomes. The results indicate that greater use of digital technologies (measured by pothole complaints) results in an increased number of votes and a higher margin of victory for the incumbent. They highlight digital technologies' role as a tool to create participatory governance mechanisms and convey to the public an image of a transparent, responsive, and capable government.

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Political Dividends of Digital Participatory Governance: Evidence from Moscow Pothole Management

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JEL classification: D72, D73, P25, P26

Keywords: digital infrastructure, elections, Moscow, pothole management

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Introduction

Participatory governance mechanisms have been widely promoted to empower ordinary citizens, promote government transparency, and improve public service delivery in developing countries (Speer 2012; World Bank 2017). The use of information and communications technologies (ICT), social media, and digital platforms have greatly enhanced the earlier patterns of public participation, creating a massive empirical ground for exploring the benefits of engaging citizens in the co-production of local information and services. Enhanced by ICT infrastructure, cities are becoming increasingly "smart," and local governments are working on involving citizens in shaping their urban environment, resolving urban problems, and monitoring policy implementation. These processes are underway in developed and developing countries (Caragliu, Del Bo, and Nijkamp 2011; World Bank 2016). The participatory mechanisms of governance enhanced by ICT and digital platforms have also blurred the boundaries between different political systems. Their use and extensions beyond classical Western democracies have attracted growing academic attention (Chen, Pan, and Xu 2016; Distelhorst and Hou 2017; He and Warren 2011; Toepfl 2018; Truex 2017).

This study explores the political effects of ICT-powered digital public engagement in the context of local politics in the Russian Federation. Specifically, we examine the political effects of ordinary Russians engaging with state officials through the digital platforms designed to draw citizens into local governance in Russia's capital city and the largest urban center, Moscow. We look at the interrelationship between the usage of online platforms that allow Moscovites to complain about the quality of local roads by reporting the potholes in Moscow and the support for the incumbent in mayoral elections in Moscow. We leverage the geocoded data from these platforms as an indicator of digital public engagement with the local government in the process of co-production and analyze the effects of this engagement on voting using a panel of precinct-level voting data for 2013 and 2018.

Our findings suggest that local digital participation on the issue of local roads is associated with 'political dividends' to the incumbent. Engagement with the city government through digital technologies (measured in our study by pothole complaints) results in an increased number of votes and a higher margin of victory for the incumbent mayor. Our identification strategy is based on the engineering literature and direct evidence from the city authorities. It exploits arguably exogenous variation in intra-city weather conditions during the heating season, which differentially affects pothole creation and is otherwise uncorrelated with electoral outcomes. This strategy allows for advancing a causal argument that stands a number of robustness tests. We rely on the additional data on the effectiveness of road maintenance across different municipalities in Moscow to propose a causal mechanism driving the observed outcomes.

The findings from this study stand in sharp contrast to similar studies undertaken in other locales that have found a reverse pattern from the public engagement with local authorities on the issue of road quality. In one of the largest cities in the United States, more pothole complaints have a significant negative effect on the incumbent vote share (Burnett and Kogan 2016). Local democracy in the United States works by holding politicians accountable for the quality of public goods delivery, as demonstrated by bad roads. On the other hand, local authorities in Moscow rely on the crowd-sourced information on road quality to demonstrate government responsiveness, repair city roads in a timely manner and win more votes with better roads. In the discussion section, we present empirical tests pointing to effective performance demonstrated in response to resident complaints on road quality as the most likely causal mechanism driving these results.

This study contributes to different strands of literature on governance and institutions. First, we contribute to the growing literature in public administration and public management on the effects of digital technologies on the co-production of public services (Joshi and Moore 2004; Linders 2012). This literature is mostly focused on the countries where co-production practices are frequently motivated by the opportunities the new technologies bring to relieve financial pressures on the government (Falco and Kleinhans 2018; Nam 2012). By investigating the political effects of digitally-driven co-production of public services, we highlight additional reasons behind these governance technologies outside the advanced industrialized world. Second, we engage with the literature on local participation and government performance in developing and post-communist countries (Besley and Burgess 2001; Sjoberg, Mellon, and Peixoto 2015; Trucco 2017). While most of this literature examines the effects of government performance on participation levels, our study takes a step further and explores the electoral effects of government responsiveness in the post-communist context of local governance. Third, we also add to the emerging literature on political effects of participatory governance in developing countries that has been dominated by the studies of China and the Chinese Communist Party's (CCP) efforts to maintain regime legitimacy (Dickson et al. 2016; He and Thøgersen 2010; Truex 2016, 2017). We bring attention to other country contexts where similar dynamics are played out in electoral politics, even if heavily managed. Finally, we add to the emerging literature on 'informational autocracies' by demonstrating that the reliance on digital platforms can be motivated by a combination of performance-based and demonstration-driven effects as opposed to solely information-manipulation mechanisms (Guriev and Treisman 2019; Rozenas and Stukal 2019; Sanovich 2017). In that, our findings resonate with recent studies of voting in hybrid regimes that link voters' support for incumbents with more directly observable indicators of regional government performance (Rosenfeld 2018).

The paper proceeds as follows. The next section provides an overview of the growing literature on the spread and effects of digital participatory governance tools along with the outstanding gaps and questions emerging from that literature. The following section specifies Moscow's political economy's context, highlighting the significance of transportation issues and road quality in the city's development strategy. After that, we describe our data and specify the empirical model and the identification strategy we employ. The fifth section describes the results and presents robustness checks. We then discuss our central findings and their contribution to the literature, followed by the conclusion.

Government Responsiveness: Leveraging ICTs in Public Goods Provision

The bourgeoning literature on digital technologies' impact on state-society relationships has evolved in different directions. A big strand of this literature has been motivated by the early optimism in the ability of new technologies to transform the relations between governments and citizens by empowering societal actors, improving the delivery of government services, increasing government responsiveness, transparency and efficiency not only in developed economies but also in the developing world (Basu 2004; Heeks 2002; Heeks and Bailur 2007). Digital governance moved to the center of academic debates in public administration and management as the analytical toolkit in this field shifted away from a 'new public management' approach to 'digital-era governance' (Dunleavy et al. 2006; Linders 2012; Margetts and Dunleavy 2013). A distinct offshoot of this literature focused on 'smart city' governance issues exploring and assessing the advances in urban policy-making relying on new participatory technologies and co-production of public services (Castelnovo, Misuraca, and Savoldelli 2016; Ismagilova et al. 2019; Meijer and Bolívar 2016). A recent review of the literature in this area noted the predominance of technical and managerial framing of this issue and the need for greater attention to the politics of smart city governance (Meijer and Bolivar 2016, 404).

The technocratic optimism frequently associated with digital governance tools derives from the expectations that these new technologies help engaging citizens in creating and using data and co-producing solutions to various problems (Goldsmith and Crawford 2014). A number of scholars have also investigated how new technologies affect and reflect citizens' trust in government (Bannister and Connolly 2011; Parent, Vandebeek, and Gemino 2005; Tolbert and Mossberger 2006). Some studies found linkages between the use of government websites and the process-based trust in government (Rainie and Larsen 2002; Tolbert and Mossberger 2006). Engaging with e-government and relying on government-created websites appears to improve popular perceptions of government responsiveness (Ibid.) With some exceptions, most of this research is conducted in the context of democratic governance. The widespread adoption of new governance mechanisms across different regions and political contexts makes it imperative that researchers explore the practices and outcomes associated with using these new tools beyond the advanced industrialized world.

The studies of participatory tools of governance in non-democratic contexts have challenged the binary division between democracies and autocracies. Mainstream classifications of authoritarian systems do not, normally, involve any formalized participation channels in the institutional make-up of these regimes (Geddes, Wright, and Frantz 2012). The implicit assumption that participation, deliberation, and consultation channels are associated with democracies inhibits our understanding of how different political systems operate. The use of participatory governance mechanisms outside classical democracies highlights the value of government responsiveness in all political contexts. Many scholars have recently inquired into the use of horizontal accountability and increasing participation channels for ordinary people in policy formation and design as well as in policy implementation and oversight in China, for example (Benton 2016; Chen, Pan, and Xu 2016; He and Warren 2011; Truex 2016, 2017; Xiaojun and Ge 2016). He and Warren (2011, 275) observed that these participation channels in China are carefully managed and channeled into the 'governance level' domain of administrative decision-making (as opposed to regime-level). Chinese rulers try to prevent collective action by aggregating and responding to issues in policy domains that are not politically sensitive yet still are of great concern to citizens (Chen, Pan, Xu 2016).

Participatory governance institutions aided the incumbents in Mexico (before democratization), Evo Morales' Bolivia, and Chavez's República Bolivariana de Venezuela (Benton 2016). Cassani (2017) argues that participatory governance institutions in electoral authoritarian regimes are more superior to politically closed dictatorships because they help rulers to overcome information and communication deficits, thereby enhancing their ability to provide social services and capacity to claim performance-based legitimation. When confronted with intense popular dissatisfaction expressed in declining votes, electoral autocracies respond with policy concessions on social welfare issues, revealing their sensitivity to the type of signals and information produced by elections (Miller 2015).

The use of digital tools of governance enables modern-day non-democratic political systems to develop and rely on participatory, deliberative, and consultative means of governance. Individual engagement with the state - that can take the form of complaints, appeals, or comments and suggestions on policies – is currently aided by the Internet and online communication channels (Balla 2017; Balla and Xie 2020; Toepfl 2018). Therefore, the more nuanced accounts of non-democratic governance and legitimation mechanisms bring both issues – performance and information technologies - to the 'analytical table' (Cassani 2017; Jiang, Meng, and Zhang 2019). Any regime can strive to provide citizens with policy improvements to enhance its popularity, gain legitimacy, and stave off collective action. The intellectual challenge is to explore the conditions that make some strategies more prevalent and more appealing than others as well as the factors responsible for why some policy spheres might be more prone to responsive forms of governance and performance-based legitimation strategy. This study makes a step in that direction by focusing on governance of the most politically important and economically affluent urban area in the Russian Federation, the capital city of Moscow. We examine the political implications of relying on participatory forms of governance introduced by the city government in relation to Moscow roads. Why do regional and city governments invest in digital tools of governance and new mechanisms of getting public feedback on specific issues? In other local contexts such mechanisms are viewed as part of holding the government accountable for policy outcomes and public goods provision (Burnett and Cogan 2017). Is government accountability the main purpose of developing such participatory governance mechanisms outside classical Western democracies? Is Moscow city government in fact interested in engaging city residents on the issue of road quality?

The literature points to two alternative hypotheses in relation to these questions. Some scholars suggest that a number of post-communist governments may rely on e-government and ICT to *simulate* service provision, implying that the growing usage of online platforms is a mechanism of manipulation of public opinion (Maerz 2016; Rozenas and Stukal 2019; Toepfl 2018). Other studies find that political legitimation strategies can rest on fulfilling 'people's will and material needs' even in non-Western democracies (Cassani 2017; Jiang, Meng, and Zhang 2019). Digital technologies make it easier to reach out to citizens and provide openness, accessibility, and participation (Linders 2012, Dunleavy et al. 2006). They also reduce the costs of getting public feedback and gathering information about potential problems in service delivery (Fountain and Osorio-Urzua 2001).

Therefore, in cases when digital platforms are used to gather information on issues of everyday importance to residents (such as roads), citizen engagement through ICT might work to enhance actual government performance and service delivery and serve as an important element of government legitimation. Scholars have demonstrated that threats of collective action can cause the non-democratic governments to increase responsiveness levels and that 'representation within bounds' allows the government to receive information on citizens' preferences and even act on some of them (Chen, Pan, Xu 2016; Truex 2016, p. 6; Distelhorst and Hou 2017). Based on this literature, our first hypothesis is based on a view that the local authorities in Moscow rely on digital governance means to ensure popular support by showing responsiveness to public demands and good performance. In our specific case of Moscow roads, responsiveness and performance are demonstrated when the city government responds to individual complaints about potholes. Moscow residents engage with the Moscow government through the local digital platform, thereby enabling the government to demonstrate its responsiveness. Based on this rationale, we conjecture that:

H1 A higher level of public engagement with a digital platform on the issue of road quality increases support for the incumbent.

The nature of the issue at hand – road quality – is an important part of the story. It is an issue of high public salience and has been shown to carry significant political implications in other country contexts (Harding 2015). It is also a policy domain that appears easier to tackle than more complex and knowledge-intensive spheres such as health care or education that depend on human capital and more complex institutional systems. Laying asphalt is arguably less reliant on complex organizations than operating a cardio-clinic, although traffic management in a big city might indeed be very complicated. Nonetheless, if the local government has the financial resources, these problems can be resolved with a proper organization in a timely fashion. It also delivers clearly visible outcomes. Therefore, maintaining good roads might be an issue that is easier to address and politically rewarding. Just like bad roads could be a systematic sore point, good roads could be a systematic reminder to city residents and car owners just how effective the city management is. Nonetheless, studies of pothole complaints in other country contexts have revealed opposing political effects of road-related complaints on local government support (Burnett and Kogan 2017). Perhaps in Moscow, as in San Diego, city residents show their frustration with public services when they complain about potholes and then act out on those frustrations during the election? Therefore, our second hypothesis suggests:

H2. A higher level of public engagement with a digital platform on an issue of road quality lowers support for the incumbent.

This logic is reasonable if we consider the Russian state's federal structure and the Kremlin's reliance on regional governors for maintaining social and political stability in the country. The federal center is interested in keeping the governors accountable for public services provision and policy-effectiveness in their regions, a problem confounded by significant informational asymmetries (Sharafutdinova 2010). The e-government mechanisms promoted by the federal center and adopted by regional governments can reduce informational costs and improve such accountability by providing citizens with a simple and direct feedback mechanism on public services (Fountain and Osorio-Urzua 2001). Citizens' complaints about roads are an important indicator of road-related problems. Given the salience of roads in such a large urban area, it could lead to a lowered electoral support for the incumbent.

Political Economy of Transport Infrastructure in Moscow

Moscow is one of 85 federal subjects of the Russian Federation and is the most affluent city in the country. With over 12 million urban residents, Moscow's 2018 gross regional product of $284,4 billion is comparable to Finland's GDP. In Moscow, per capita Gross Regional Product is almost twice that of the country average. Likewise, the average salary in 2019 in Moscow was over 90 thousand rubles compared to under 40 thousand rubles across Russia.[2] Under mayor Sergei Sobyanin (2010-present), named 'an urban renewal priest,' the city has undergone a radical infrastructural development (Gershkovich 2018). Sobyanin, who succeeded mayor Yuri Luzhkov (1992-2010), declared an ambitious goal of bringing Moscow to the top tier of global cities in terms of comfortable and modern living conditions. Some observers viewed this as a new political strategy for the Moscow mayor to win the support of 'angry urbanites' who flocked to the streets in the

[2] https://iz.ru/963676/2020-01-14/analitiki-podschitali-sredniuiu-zarplatu-v-rossii-za-2019-god
https://visasam.ru/russia/rabotavrf/srednyaya-zarplata-v-moskve.html [last accessed: August 2020].

2011-2012 protests.[3] The goal of improving city amenities remained at the heart of Sobyanin's electoral strategy in the following years.

Transport infrastructure became one of the centerpieces of the urban renewal in Moscow. Over the last decade, the Moscow government has made massive investments into transport infrastructure development in the city, including building new roads and fast-speed highways as well as developing public transit and the Moscow metro system (Liskutov 2018). 1.4 trillion rubles, or 67% of Moscow's Targeted Investment Program for 2020-2022, is planned for the development of the city's transport system.[4] Such massive resources invested in developing transportation and roads in Moscow are not accidental. The issue carries not only economic but also political significance. The quality of roads and the transportation system's effectiveness is a policy domain in the life of a big city that is of high salience for the millions of daily commuters in the city.[5] It directly affects the quality of life in the city and could potentially be a source of frustration and discontent – a 'sore' point that reminds daily (and often many times throughout the day) about the ineffective and corrupt government. Mikhail Blinkin, director of the HSE Institute for Transport Economics and Transport Policy Studies and one of the most notable Russian transportation systems experts, also highlights the political rationale guiding the development of transport infrastructure in Russian cities:

> *The centerpiece of a typical urban agenda related to the transportation problems has to do with private car ownership and include characteristic issues such as "struggle against traffic jams," "parking lots," and, most importantly, "multilevel interchanges." These days, multilevel interchanges occupy a remarkable position in the collective unconscious of Russian car owners and local politicians. Promises to build new interchanges often seem to be in the very heart of election programs at municipal elections* (Blinkin and Koncheva 2016, p.280).

Blinkin also notes that the most important item on this agenda is road maintenance:

> *The long-term shortage of funds for maintenance and repair of road network, usual for the majority of Russian cities, leads not only to the destruction of pavement but also to the degradation of structural layers of a road-way, down to the sub-base. Accordingly, holes and potholes on roads and streets become a political rather than merely transport-related issue* (Blinkin and Koncheva 2016, p.280).

The issue of road quality and maintenance was politicized in Moscow since 2010 when Alexey Navalny's (Russia's only notable opposition leader) *Foundation Against Corruption* developed an

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[3] https://www.vedomosti.ru/opinion/columns/2019/09/05/810614-urbanizm-mertv?utm_campaign=newspaper_6_9_2019&utm_medium=email&utm_source=vedomosti [last accessed: September 2020]

[4] https://investmoscow.ru/about-moscow/moscow-city-targeted-investment-program/ [last accessed: September 2020].

[5] The government of the City of Moscow estimates that in 2019 there were around 7.7 million of registered cars, of which 3.2-3.6 million car owners are daily commuters. See https://rg.ru/2019/04/18/reg-cfo/eksperty-podschitali-kolichestvo-avtomobilej-v-moskve.html [last accessed: September 2020].

application *Rosyama* (rosyama.ru) as a means to address the problem of potholes in the city and the mechanism of keeping the local government accountable.[6] This mobile application allows its users to geolocate a road problem (besides potholes, it included broken rails, snow accumulation, open manholes, and persistent puddles), take a picture, and place it on the map. The application then generates a text complaint forwarded to the local Road Inspectorate (Ermoshina 2014). Ermoshina (2014) observes that between May 2011 and May 2014, 56,919 potholes were reported using *Rosyama* digital application, and 15,966 of those were repaired. Researchers referred to *Rosyama* and other related web applications, as 'civic applications' and as instruments of citizens' legal empowerment. They were conceived as instruments for keeping the local administrators accountable for their responsibilities. Navalny's team intended these applications as a means for generating collective action in a wider fight against corruption in Russia. Not all of these opposition plans achieved their desired ends. Some of these initiatives in the digital sphere were 'highjacked' by the city government.

The Russian government invested heavily in digital tools of government since Dmitry Medvedev's presidency, during 2008-2012. The Moscow city authorities also actively developed digital instruments of governance and have invested massive resources into promoting a 'smart city' agenda. Its most recent strategy document, "the Smart City – 2030," outlined the main goals and objectives of a continuing urban transformation (City of Moscow 2018). The 2018 United Nations e-government survey of 40 cities across the world ranked Moscow as a leading city (along with Cape Town and Tallinn) in using information and communication technologies to deliver public services (United Nations 2018). The major city redevelopment plans included a new system of feedback from the city residents – "Active Citizen" – an electronic voting platform deploying blockchain technology to ensure transparency and non-interference with the results.[7] Additionally, Sergei Sobyanin invested in the new online portal *Nash Gorod* (gorod.mos.ru), translated as "Moscow – Our City". The portal was introduced in 2011 and aimed at getting feedback on infrastructural issues in the city, including roads, housing, courtyards as well as other city-related concerns.

The application to report potholes in the city was introduced in 2012 and merged with *Nash Gorod* later in 2013. To activate these services, Moscow residents have to download the mobile

[6] *Rosyama* was not the only mobile app created by the Foundation Against Corruption. Other applications included RosZKH, helping residents write petitions to the Housing Inspection Committees on problems of housing infrastructure services.

[7] While promoted by some as an example of 'blockchain democracy,' this system was critiqued as an example of a technology that promotes a false sense of empowerment (Zionts 2018). The numerous referenda organized on this platform address trivial questions such as the names for the subway stations but do not deal with more meaningful issues such as hospital closures (Ibid).

application '*Nash Gorod*' and register with the mobile phone number. They can then send complaints, selecting a problem they encounter, and accompanying the message with a photo. All complaints are accumulated in the portal's 'editing office,' where thirty moderators assign the complaints to authorities responsible for the specific road under question. These decisions are made within 24 hours. The portal claims that most problems are resolved on average in five days. On the issue of road maintenance, the portal adheres to the city Resolution 762-PP,[8] which requires the ongoing road repairs in response to public complaints to be completed within eight business days from the time of the complaint. Because of its simplicity of use and effectiveness with public service delivery, the portal has since become the largest aggregator of complaints about potholes along with complaints in other spheres of life in Moscow, such as public transportation, various municipal services, illegal businesses, abandoned vehicles, street advertisement issues, etc. Currently, the site reports over 1.5 million portal users and over 3.9 million resolved complaints since 2011.

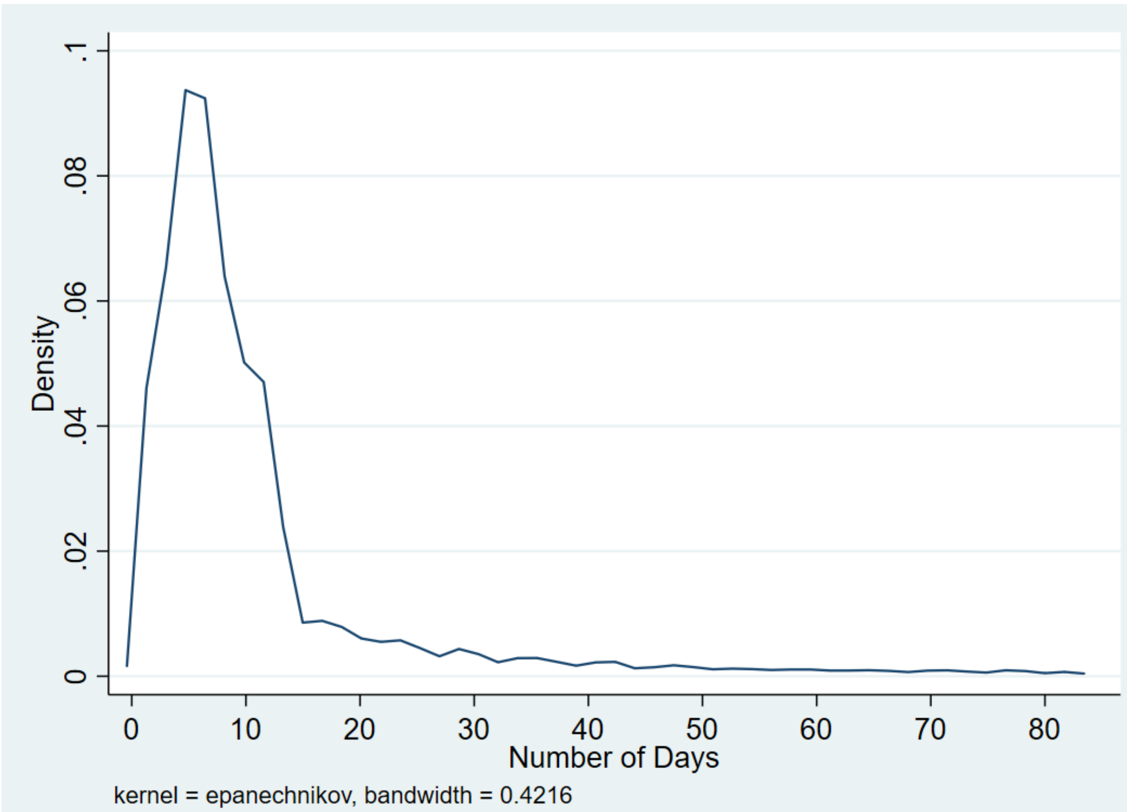
Data and Empirical Model

Our analysis employs data at the municipal level of the city of Moscow over the period between the two most recent mayoral election rounds, 2013 and 2018. We scrape the electoral data (votes for the registered candidates and the turnout) from the Central Electoral Commission of the Russian Federation website.[9] We scrape the data about pothole complaints from the two online platforms described in the section above: *Rosyama* (7,709 total complaints) and *Nash Gorod* (205,935 total complaints).[10] As we explain above, while having considerably fewer records, the former platform was important in the early years of our data sample. Both online platforms provide information about the location of the pothole (at the municipal level), the date the complaint was registered, the unique user id who has registered the complaint, and the outcome of the complaint. Additionally, the *Nash Gorod* website reports the information about the municipal authority responsible for addressing the complaint, the dates when the authority responded to the complaint, and when the

[8] Entitled: "On approval of the Requirements for the sanitary-technical maintenance of the road facilities of the Moscow city road network and the Procedure for the overhaul, maintenance, marking and maintenance of the road facilities of the Moscow city road network".
[9] http://www.izbirkom.ru [last accessed: September 2020].
[10] Not only city authorities in Moscow but also other pro-government organizations have introduced their own online platforms for reporting potholes and other road-related problems. The pro-government NGO "All-Russian People's Front" (ONF), for example, introduced online platform https://dorogi-onf.ru/ for reporting potholes and other road-related problems. This and other platforms, however, are not very popular among Moscow residents. Over the entire period of the study the ONF website has registered less than 300 complaints. These data are therefore not included in our analysis.

problem was addressed. For technical reasons, neither of the two platforms registers complaints of the residents of "New Moscow," i.e., the 21 settlements of the Moscow Oblast incorporated in the city of Moscow in 2012. Therefore, we restrict our analysis to Moscow's 125 municipal districts, excluding the "New Moscow" territory.

Figure 1. Kernel Density Plot of the Response Time to Pothole Complaints



Note. Source: authors' calculations based on scraped data from *gorod.mos.ru* over the period 28 August 2012 - 30 April 2019. For illustration clarity, the right tail of the distribution is winsorized at 95 percent-level. The response time measures the difference between the date the complaint was registered, and the final response of the official confirming the complaint was addressed.

The main explanatory variable in our analysis is pothole complaints registered by Moscow residents using the above-mentioned online platforms over the period of this study. We assume this indicator measures the degree of digital public engagement in requesting essential local public services, which, in our case, is improving the quality of city roads. An alternative interpretation of this variable is that it captures the variation in the quality of local public services, i.e., the management of local city roads. This interpretation is less likely because roads in Moscow are very well managed. Figure 1 shows the kernel density plot approximating the distribution of the response time to pothole complaints, i.e., the difference between the date of the complaint's registration and official confirmation that the complaint has been addressed. We see that the distribution peaks at eight days, i.e., the time the pothole has to be repaired by Moscow city ordinance. And 80 percent of all complaints are addressed in the two weeks' time, indicating a highly efficient response rate.

We employ three popular measures of electoral competitiveness as our dependent variables.[11] The *total votes for the incumbent* measure shows the degree of overall support for city authority among the voters. The *margin of victory* measure (i.e., the difference between the votes for the election winner versus the runner-up candidate) indicates the city authority's electoral strength vis-à-vis opposition candidates. The *voter turnout* measure (i.e., the percentage of eligible voters who cast the ballot) captures the degree of city residents' overall electoral engagement.
Appendix Table A.1 shows the summary statistics for the variables employed in the empirical analysis.

We model the effect of digital public engagement by estimating the following empirical specification:

$$Y_{i,t} = \rho \sum_{i \neq j} w_{i,j} Y_{j,t} + \sum_{m=M-K-3}^{M-K} X_{i,t,m}\beta + \alpha_i + \gamma_t + \epsilon_{i,t} \, . \qquad (1)$$

The specification described by equation (1) is the spatial autoregressive model (SAR) for panel data (Elhorst 2014; LeSage and Pace 2009), where indices {*i,j*}, *t* and *m* describe municipalities, years, and months before elections date, respectively; $Y_{i,t}$ indicates measures of electoral competitiveness; $X_{i,t,m}$ indicates the degree of digital public engagement measured by cumulative pothole complaints over the 3-months rolling window *M-K*, where *K* are months before the election month, *M*; $w_{i,j}$ is the element of the spatial weight matrix; ρ, β, α_i and γ_t are parameters to be estimated with ρ indicating the spatial lag (i.e., the degree of spatial autocorrelation among the electoral competitiveness in neighboring municipalities), and α_i and γ_t indicating municipality and time effects, respectively; and $\epsilon_{i,t}$ is the error term. We choose the SAR model as the base empirical specification instead of the more commonly used linear panel data model with fixed effects because

[11] The use of electoral results from Russia in a study such as this inevitably raises the issue of electoral fraud that have tainted Russian electoral practices at various government levels at least since the 1996 presidential elections (Enikolopov et al. 2013; Kalinin and Mebane 2012; White 2016). There are several reasons why we can still rely on Moscow elections as reflecting, even if imperfectly, the popular will of the city residents. Moscow along with St. Petersburg are the cities with the highest number of independent election observers that limit opportunities for outright fraud, and their importance has increased during the last decade. The evidence is also accumulating that incumbents in Russia often revert to electoral manipulation strategies that are less visible than ballot-box stuffing and less costly in terms of public attention and fury: they manipulate institutions and electoral rules to prevent challengers from running in the first place (Szakonyi 2019). Indeed, the independent watchdog "Golos" agreed that Moscow 2018 elections did not experience fraud, though it questioned the fairness of the incumbent's electoral strategies (https://www.kommersant.ru/doc/3737769, [last accessed September 2020]).

the assumption of spatial independence of the electoral competitiveness measures is likely to be violated. We calculate the spatial weight matrix based on the inverse centroid distances between each of Moscow's 125 municipalities.

The key parameter to be estimated is β, which captures the local marginal effect of digital public engagement on electoral competitiveness, conditional on observed exogenous variation across municipalities, and election years. To accurately quantify this effect and obtain a consistent estimate of β from estimating empirical specification (1), we need to assume that the explanatory variable is strictly exogenous, i.e., $\mathbb{E}\left[\epsilon_{i,t}|X_{i,t}, \alpha_i, \gamma_t\right] = 0$. The concern is that our measure of digital public engagement is endogenous to electoral competitiveness. One reason is that both variables may respond to unobserved factors that are omitted from the model. For example, both registered pothole complaints and the number of votes for the incumbent could reflect the degree of public satisfaction with other Moscow city authority policies or the incumbent's political party. Alternatively, there could be a reversed causality problem, as increased electoral competition could also affect the degree of digital public engagement. In the presence of these problems, maximum likelihood or least squares estimates of the empirical specification (1) will be biased and inconsistent.

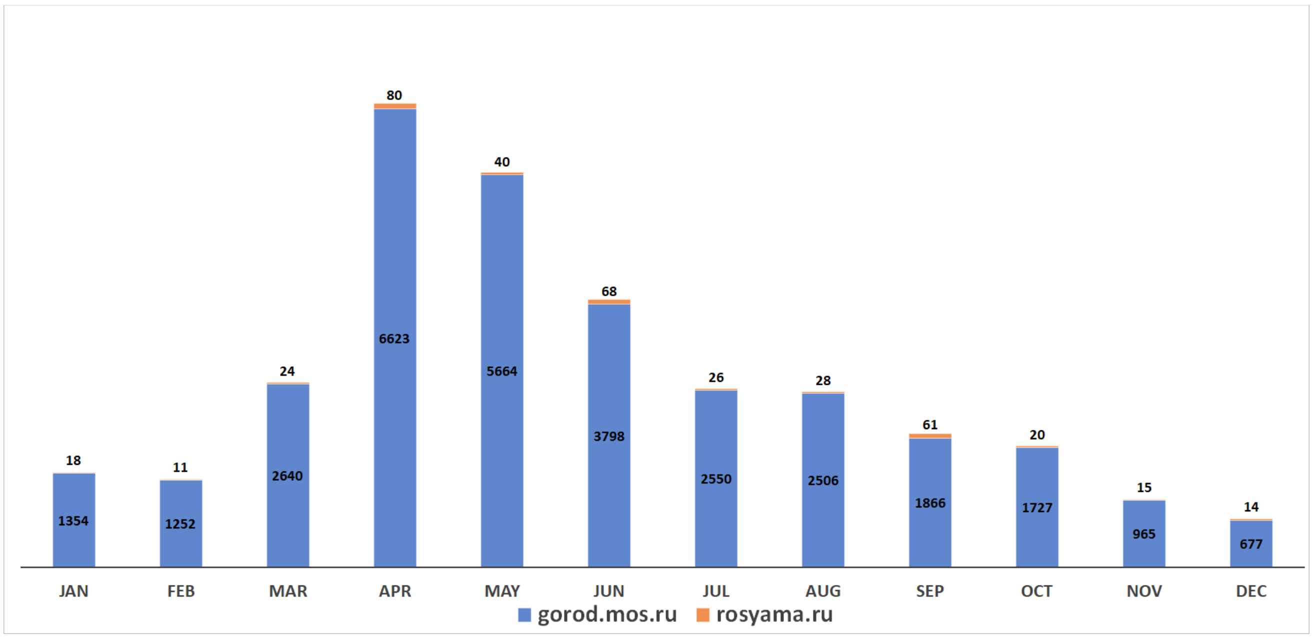
To address this concern, we construct instrumental variables for the potentially endogenous regressor. To do so, we have to identify measures correlated with digital public engagement but not otherwise associated with electoral competitiveness measures. More specifically, chosen instruments must have a significant partial correlation with reported pothole complaints conditional on all other exogenous terms, including municipality and year dummy variables, and uncorrelated with the error term, $\epsilon_{i,t}$. If chosen instruments satisfy these exclusion restrictions, the identification of the parameter β comes from within municipal variation over time in the instruments.

Our approach for identifying valid instruments is to specify biophysical characteristics of the potholes' creation process that can be arguably correlated with potholes' complaints. We assume that an increase in the number of potholes in the city is associated with a greater amount of pothole complaints. And the increase in the number of potholes due to natural causes (e.g., due to weather conditions) is arguably exogenous to digital public engagement other than reporting potholes. The engineering and material science literature (Gilmore et al. 1985; Guo et al. 2018) identifies the frequency of freeze-soak-scour cycles in the spring-thawing season as the main cause of pavement damage in the areas affected by winter frost. Moscow's geographical location and exposure to harsh winters make the city an ideal case for this particular factor affecting local road quality. Moscow city authorities also acknowledge this as the key driver affecting pothole creation in the city. Citing Alexander Oreshkin, the head of the Moscow's state budgetary institution "*Avtomobil'nye Dorogi,*" the main organization responsible for servicing and maintenance of Moscow city roads:

> *The only big problem this winter is pothole repair. As the temperature passes through 0° C, for example, it is 2° C in the daytime, and at nighttime, it is -4° C, moisture gets into the pores, asphalt in some places gets destroyed, and it is necessary to repair it quickly.* (RIA Novosti 2020).

Our data about pothole complaints similarly indicate that the largest number of pothole complaints occurs in April and May after the snow and ice melts and potholes become more visible (Figure 2).

Figure 2. Monthly Variation in Pothole Complaints, 2018.



Based on this scientific and policy evidence, we construct our instrumental variable as the total number of days in the heating season preceding the election year that satisfy the following two conditions:

(i) the 24-hour temperature has switched at least once between positive and negative values; and

(ii) there was precipitation in the form of rain or snow.

That is, we calculate our instrumental variable, $Z_{i,t}$, as follows:

$$Z_{i,t} = \sum_{\tau=1}^{T} \mathbf{1}^{\mathbf{S}}\left(s_{\tau,i}\right) \cdot \mathbf{1}^{\mathbf{P}}\left(p_{\tau,i}\right), \qquad (2)$$

where T is the number of days in the heating season preceding the election year, $s_{\tau,i}$ and $p_{\tau,i}$ are the number of recorded daily instances of temperature switches and precipitation in day t in municipality i, and $\mathbf{1}^{\mathbf{S}}$ and $\mathbf{1}^{\mathbf{P}}$ are the indicator variables, which take the value of one if $s_{\tau,i} \in \mathbf{S}(0, s^{max}]$ and $p_{\tau,i} \in \mathbf{P}(0, p^{max}]$, and zero otherwise.[12]

We calculate the duration of the heating season each year based on the rule posted on the official website of the Moscow mayor[13], which foresees that,

> *In Moscow, heating is turned on by order of the City Government if the daily average temperature is below 8°C for 5 days, and the weather forecast expects a further decrease. Heating is turned off according to the same principle - if the average daily temperature for 5 days keeps above 8 °C, and according to the weather forecast, it is expected to increase further.*

To calculate the duration of the heating season, we use the archived daily temperature of Moscow VDNKh weather station, posted on the website of *Raspisaniye Pogodi Ltd*, a weather forecast company based in Saint-Petersburg, Russia.[14] We use the same weather archive to obtain the recorded daily instances of temperature switches and precipitation for 13 weather stations located in the city of Moscow and Moscow oblast in close proximity to the city of Moscow. We apply the kriging procedure to interpolate these weather data and compute the switch and precipitation instances at the municipal level. The details are available in the Appendix.

Using the calculated instrumental variables, we specify the following first-stage equation:

$$\sum_{m=M-K}^{M} X_{i,t,m} = \rho_X \sum_{i\neq j} w_{i,j} \sum_{m=M-K-3}^{M-K} X_{i,t,m} + Z_{i,t}\beta_{IV} + \alpha_i + \gamma_t + \omega_{i,t} \,. \quad (3)$$

The first-stage equation (3) also estimates the SAR model for panel data, as we cannot rule out the spatial independence of pothole complaints. The notation in equation (3) closely parallels the one in equation (1), where ρ_X indicates the spatial lag of pothole complaints, β_{IV} is the parameter measuring the marginal effect of the instrumental variable, and $\omega_{i,t}$ is the error term. If our instrumental variables are correctly specified, we expect the β_{IV} parameter to be positive and statistically significant.

[12] For robustness purposes we also calculate an additional instrumental variable, which accounts only for the total instances of daily temperature switch, ignoring precipitation effects. This variable was highly correlated with our preferred instrument, and the first-stage estimates using this variable were little changed.

[13] https://www.mos.ru/otvet-dom-i-dvor/kogda-vklyuchayut-i-otklyuchayut-otoplenie-v-moskve/ [last accessed: September 2020].

[14] https://rp5.ru/docs/about/en [last accessed: September 2020].

Equations (1) and (3) are jointly estimated using the generalized method of moments estimator derived in Kapoor, Kelejian, and Prucha (2007), and implemented in R statistical software (Millo and Piras 2012).

Results and Robustness Checks

This section describes the results of hypotheses testing based on the estimation of regression equations (1) and (3). Table 1 reports the generalized method of moments (GMM) estimates of these equations, with the explanatory variable cumulative values calculated over the 3-month window before elections to the election date.

The first-stage coefficient estimates of the marginal effect of the instrumental variable, β_{IV} are positive and statistically significant. This is consistent with our expectation that potholes are more likely to appear in the municipalities with a larger number of daily temperature switches and more precipitation during the heating season. The Wald test confirms that the constructed instrumental variable cannot be excluded from the first stage without loss of statistical significance, rejecting the null hypothesis of weak instruments. The estimated spatial lag coefficient of the pothole complaints, ρ_X, indicates negative spatial dependence.

Turning to the second stage estimates, we see that the estimated marginal effect of digital public engagement measured by pothole complaints, β, is positive and statistically significant in equations with total votes for incumbent and the margin of victory as dependent variables. Moreover, in both equations, the magnitude of the estimated coefficient increases as the election date gets closer. These results indicate a sizeable positive effect of digital public engagement on the electoral support for the incumbent. Conditional on the municipal- and election year- fixed effects, each pothole complaint is associated with additional 29 to 44 votes for the incumbent and 18 to 27 votes increase in the margin of victory. The last column of Table 1 shows that an increase in digital public engagement also leads to a slightly lower turnout. However, this effect is not statistically significant. The estimated spatial lag coefficient of electoral competitiveness indicators, ρ, indicates positive spillovers from neighboring municipalities. This coefficient, however, is not statistically significant.

Table 1: Effect of Digital Public Engagement on Electoral Competition

Dependent variable:	N.Complaints	V.Incumbent	M.Victory	Turnout
GMM Stage:	I	II	II	II
PANEL A: 3-6 months before the election				
ρ_X	-1.11**			
	(0.53)			
β_{IV}	8.22***			
	(1.99)			
ρ		0.44	0.33	1.82
		(0.97)	(0.94)	(2.25)
β		30.75***	18.81***	-0.001
		(7.75)	(6.16)	(0.007)
Wald χ^2 (p)	16.97 (0.00)			
PANEL B: 2-5 months before the election				
ρ_X	-1.12**			
	(0.53)			
β_{IV}	7.78***			
	(2.09)			
ρ		1.02	0.92	1.51
		(0.83)	(0.80)	(1.99)
β		28.99***	18.16***	-0.001
		(7.46)	(5.90)	(0.007)
Wald χ^2 (p)	13.73 (0.00)			
PANEL C: 1-4 months before the election				
ρ_X	-1.08**			
	(0.50)			
β_{IV}	4.15***			
	(1.48)			
ρ		1.04	1.03	1.39
		(0.70)	(0.68)	(1.77)
β		40.66***	26.67***	-0.008
		(10.66)	(8.40)	(0.01)
Wald χ^2 (p)	7.80 (0.00)			
PANEL D: 0-3 months before the election				
ρ_X	-0.38			
	(0.37)			
β_{IV}	3.45***			
	(1.21)			
ρ		0.77	0.82	1.76
		(0.71)	(0.68)	(1.78)
β		43.70***	27.23**	-0.004
		(13.28)	(10.46)	(0.01)
Wald χ^2 (p)	8.06 (0.00)			
Observations	250	250	250	250
Year & Spatial Fixed Effects	Yes	Yes	Yes	Yes

Note. Each column represents a separate regression. Panels A, B, C, and D report 3-month windows over the period [M-K-3, M-K] before elections. N.Complaints is the number of cumulative digital potholes complaints over the three months window before elections. V.Incumbent, M.Victory, and Turnout are, respectively, total number of votes for the incumbent, the margin of victory of the incumbent, and the voter turnout. ρ_X indicates the spatial lag of complaints in the regression first stage. β_{IV} is the marginal effect of the instrumental variable defined in equation (2). ρ is the spatial lag of the dependent variable in the regression second-stage. β measures the marginal effect of digital public engagement (proxied by digital pothole complaints). The Wald test χ^2 (p-value in parentheses) measures the joint significance of the excluded instruments. Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

We then perform a number of robustness checks to evaluate the extent to which the magnitude of our estimated coefficients is affected by potentially confounding factors, and further strengthen the credibility of our identification strategy. First, following Burnett and Kogan (2017), we perform the placebo test to see if there are omitted variables that are correlated with voting behavior and the propensity to file pothole complaints, which are not accounted for by the municipality and year fixed effects, or correlated with our instrumental variable thus possibly confounding estimation results. As Burnett and Kogan (2017, p. 309) argue, "these variables should affect complaints filed in the six months after the election just as much as they affect complaints in the six months before-hand."

Table 2: Digital Public Engagement on Electoral Competition: Placebo Test

Dependent variable:	V.Incumbent	M.Victory	Turnout
PANEL A: 3-6 months after the election			
ρ	0.19	0.24	-0.80
	(0.33)	(0.31)	(0.56)
β	16.62**	5.04	0.007
	(8.21)	(6.42)	(0.007)
PANEL B: 2-5 months after the election			
ρ	0.18	0.21	-0.81
	(0.34)	(0.32)	(0.56)
β	13.74	-2.82	0.01
	(12.10)	(9.42)	(0.01)
PANEL C: 1-4 months after the election			
ρ	0.19	0.22	-0.81
	(0.33)	(0.31)	(0.56)
β	27.98	0.59	0.01
	(17.84)	(13.92)	(0.01)
PANEL D: 0-3 months after the election			
ρ	0.18	0.22	-0.85
	(0.34)	(0.31)	(0.57)
β	26.68*	3.32	0.02*
	(15.26)	(11.92)	(0.01)
Observations	250	250	250
Year & Spatial Fixed Effects	Yes	Yes	Yes

Note. Each column represents a separate regression. Panels A, B, C, and D report 3-month windows over the period [M-K-3, M-K] after elections. V.Incumbent, M.Victory, and Turnout are, respectively, total number of votes for the incumbent, the margin of victory of the incumbent, and the voter turnout. ρ is the spatial lag of the dependent variable. β measures the marginal effect of the placebo variable (proxied by cumulative digital pothole complaints over K months after election). Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

However, the complaints made after Election Day are much less likely (or not at all) to affect the voters' decisions made on or before Election Day. Our empirical setting also addresses two important limitations of Burnett and Kogan's (2017) placebo test: high temporal autocorrelation of the distribution of pothole complaints and reporting of old potholes after elections. First, as we see from Figure 2, the number of potholes within neighborhoods in our study is weakly correlated over time. This is because the pavement condition is significantly better in the period after the election (i.e., during the heating season) when major repairs are done, and the damage has not materialized, compared to the period before the elections. Second, because Moscow roads are well managed, and potholes complaints are quickly addressed, there is a very low likelihood that potholes reported after the election are the ones that have existed before Election Day.

Table 2 reports the results of the placebo test. Pothole complaints after elections have no statistically significant effect (at 5 percent significance level) on voter turnout and the margin of victory indicators of electoral competitiveness. As regards total votes for the incumbent, among the four periods we report, only one outlier period (3-6 months after elections) has a statistically significant coefficient of placebo variable, which is about two times as low as the one on the explanatory variable reported in Table 1. All in all, the results of this placebo test indicate future complaints have a minimal (if any) effect on electoral competitiveness.

Second, we explore the possibility that both the dependent and explanatory variables in equations (1) and (3) are spatially dependent. In doing so, we re-estimate the system of equations (1) and (3), adding the spatial lag of the explanatory variables (i.e., pothole complaints in equation 1, and the instrumental variable in equation 3) in both equations. Appendix Table A.4 shows the estimation results. The spatial lag of explanatory variables in both equations appears highly statistically significant. The estimated effects of digital public engagement on total votes for incumbent and the margin of victory are higher (an increase of 39 to 59 votes for the incumbent, and 27 to 41 votes in the margin of victory) and are highly statistically significant. The effect on voter turnout is little changed. These results indicate that our baseline specification reflects the range of conservative estimates of the effect of digital public engagement on electoral competitiveness.

Third, we investigate whether the pothole management depends on the type of road where the pothole is reported. Although we show earlier in Figure 1 that, on average, potholes are quickly repaired, one can hypothesize that larger and more important city-wise objects are better managed, affecting our baseline specification estimates. To address this concern, we disaggregate the average time of addressing pothole complaints by the type of the road, proxied by the rank of responding official. The complaints answered by the city- and district- level official reflect the more important roads city-wise, whereas the complaints responded by municipal officials reflect smaller roads.

Finally, responses of local-level officials (typically local-level housing & communal services officials) indicate potholes on the territory of small municipal agglomerations, e.g., housing cooperatives.

Table 3 shows that although more than 50 percent of reported complaints are at the city-and district-level, there is no economically significant difference across the response complaints by the responding officer's rank. The median time of response varies between 7 and 9 days and is consistent with the Moscow city Resolution 762-PP. The complaints responded at the municipal-level take a bit longer to address (only 47.5 percent are answered within 8 days' time), but more than 80 percent of these complaints are handled within two weeks. The complaints responded at the community-level have a relatively lower completion rate within the two weeks' time (78.2 percent versus more than 80 percent at the municipality-, and city- and district- level), but the difference is not economically significant.

Table 3. Pothole Complaints by the Type of Responding Official, 2012-2019.

Responding Official	Total Number of Complaints	Median Time between the Complaint and Resolution (days)	% of Complaints resolved in 8 days' time	% of Complaints resolved in 15 days' time
City- and District-level	90,881	7	59.1	80.5
Municipality-level	30,545	9	47.2	80.9
Community-level	46,477	8	56.0	78.2
Total	167,903	8	56.1	80.0

Note. City- and district-level responses are by the heads of city and district prefectures, roads inspectorates, and budgetary institutions "*Avtomobil'nye Dorogi,*" *"Gormost,"* *"Mosvodostok,"* and *"Mosvodokanal."* Municipality-level responses are by heads of municipal administration (*uprava*). Community-level responses are by heads of municipal budgetary institutions for communal and housing services *"Zhilischnik."*

Source: authors' calculations based on scraped data from *gorod.mos.ru.* Among 175,386 scraped data points, the rank of the responder was not stated in 7,483 cases.

Even though Table 3 suggests no significant differences across responding officials' rank, we perform an additional robustness check by estimating our empirical specification based on subsample excluding potholes complaints on major city roads.[15] Appendix Table A.5 shows that excluding these complaints has a minimal difference on both first- and second-stage estimates, further rejecting the hypothesis of systematic differences across potholes' complaints on roads of different size and importance.

Fourth, a related issue is whether Moscow residents observe fixing of potholes *in response* to the registered pothole complaints or as a result of planned roadworks, which might make the coincidence between digital complaints and road fixing merely spurious. The issue of road maintenance in Moscow is highly regimented, and the frequency of road repairs depends on the type of road, as discussed in Table 3. It is implausible to expect that the city's planned repairs match all the potholes reported by city residents (our database includes close to 200,000 potholes). Furthermore, the city portal and the media in Moscow allow for the necessary degree of transparency: the portal users get a response from city authorities and can expose the cases when such a response does not reflect the reality on the ground.[16]

Fifth, one may be concerned with whether pothole complaints capture the local digital engagement and whether the complaints come from the municipalities the reporting users live in or are made by the commuting users. In the extreme case, if all complaints are made by users who do not reside in the municipality the complaints are reported (and voting occurs), our model estimates will not necessarily imply the hypothesized effect of local digital public engagement on the electoral outcomes.[17] To address this concern, we calculate the municipal breakdown of pothole complaints of unique users.

Table 4. Potholes complaints by the municipality of reporting users

Number of Municipalities	Number of Users	Percent of Users
One municipality	23,878	75.7
Two municipalities	3,821	12.1
Three municipalities	1,432	4.5
Four municipalities	678	2.1
More than four municipalities	1,753	5.6
Total	31,562	100.00

[15] Source: https://101hotels.com/recreation/russia/moskva/infrastructure/main_streets [last accessed: August 2020].
[16] There were indeed cases when the city officials reported about the resolved issues on the city portal by posting photoshopped pictures. These individuals were exposed and lost their jobs in the aftermath of such discoveries.
[17] Even in this hypothetical case we still see the effect of the digital engagement, as local residents will arguably reap the greatest benefits of fixed roads due to reported complaints. But such digital engagement is not be local.

Table 4 shows that out of nearly 32,000 individual users, 76 percent report complaints about only one municipality; 12 percent report complaints about two municipalities. The remaining 12 percent report complaints about three or more municipalities. These results indicate that most users are concerned about potholes in only one municipality, presumably their residence.[18]

Sixth, if the instrumental variable is not randomly assigned across the municipality-temporal cluster, the exclusion restriction is violated, and our estimates will be biased and inconsistent. To test for this potential violation of exclusion restriction, we perform a balancing test by regressing our instrumental variable on a number of time-varying geophysical, economic, and social indicators disaggregated at the municipal level, which we collected from the municipal statistics website of the Russian Federal State Statistic Service, ROSSTAT.[19] Appendix Table A.6 shows that none of the estimated coefficients of indicator variables came up as statistically significant, rejecting the non-random assignment hypothesis.

Finally, our estimates could be biased if they are confounded by potentially omitted political preferences of *Rosyama* and *Nash Gorod* users. Because *Rosyama* is the political opposition project, one could assume that the complaints made through that application would concentrate in municipalities less likely to vote for the incumbent Moscow mayor. To test this hypothesis, we perform a balancing test of online platforms by regressing the share of complaints made through *Rosyama* in 2013 on electoral competition measures.[20] Appendix Table A.7 shows the results of the balancing test. The share of complaints made through *Rosyama* does not seem to result in a statistically significant difference in any of the three measures of electoral competitiveness we employ, rejecting the hypothesis of user selection bias.

Discussion

The main results of our analysis support hypothesis (H1) about the positive political effects of digital public engagement on the issue of road quality in Moscow. Moscow city authorities have actively invested in participatory mechanisms of local governance. Our examination of digital means of ensuring road quality in Moscow reveals that the higher engagement with these governance

[18] Unfortunately, neither of two online platforms shows the address of the reporting user.
[19] Source: https://rosstat.gov.ru/munstat, [last accessed: September 2020].
[20] We focus on 2013 because this was the year when both platforms had roughly equal shares of complaints. Since then, the share of total complaints made through *Rosyama* has drastically fallen and, even if bias was present, unlikely to make any significant effect on estimated coefficients.

mechanisms on the part of the city residents enhances electoral support for the Moscow mayor as indicated by our two measures of such support (the overall number of votes for the incumbent mayor and the margin of victory). What is the causal mechanism driving these results? Do Moscow authorities rely on crowd-sourced information on road quality to quickly react to road problems and thereby demonstrate high performance? This pathway highlights the information-gathering function of the pothole complaints system and the performance-driven voting results in Moscow city. The alternative causal mechanism might reveal the degree to which these new means of engaging with the local state leave those who participate in the co-production of 'good roads' in Moscow feel empowered and in touch with the local government (i.e., with enhanced trust for the government). Studies conducted by the World Bank in Russia have found that participatory local governance projects directly involving the population in identifying problems and their solutions improve relations of local communities with local authorities, increase public trust in local governance mechanisms and satisfaction with local infrastructure and services (Shulga et al. 2019; Shulga, Sukhova, and Khachatryan 2014). The engagement enhancing effects are present not only in projects implemented in rural communities but also in digitally-enabled participatory governance projects in other cities and localities such as participatory budgeting projects in the cities of Tver and Surgut.[21] The Moscow government digital platform might produce the same effects.

These causal pathways appear plausible and might be at work simultaneously in the case considered in this study. However, it is important to highlight that numerous studies have shown that the degree of public participation itself is influenced by government responsiveness (Sjoberg, Mellon, and Peixoto 2015). These findings imply that the mere use of technology without the expected feedback from the government does not work to boost support for the authorities. On the contrary, as the case of San Diego reveals, if roads are bad, the incumbent is punished. Furthermore, our findings show that each pothole complaint increases the number of votes for the incumbent by a considerably larger amount than one vote (specifically, the boost is anywhere between 29-44 votes), thereby implying that the causal mechanism is driven by something other than the impact on the individual who has engaged with the government. We were able to further clarify this issue by using the available data.

We have already noted earlier the efficiency of road maintenance systems in Moscow in terms of the time allocated for fixing the revealed problems. An additional test of the importance of

[21] https://bftcom.com/expert-bft/8964/ [last accessed: September 2020].

effective pothole management on electoral outcomes was revealing. Specifically, we calculated the repairs' effectiveness measure as the ratio of the total time spent on all reported pothole repairs (in days to municipality area (in square kilometers). We then estimate the spatial autoregression model (1) to see if this *effectiveness* measure explains electoral outcomes.

Table 5: Effect of Pothole Management Effectiveness on Electoral Competition

Dependent variable:	V.Incumbent	M.Victory	Turnout
	PANEL A: 3-6 months before the election		
ρ	0.11	0.17	-0.79
	(0.36)	(0.33)	(0.56)
β	-8.26	-8.95*	-0.001
	(5.90)	(4.57)	(0.005)
	PANEL B: 2-5 months before the election		
ρ	0.13	0.19	-0.78
	(0.35)	(0.32)	(0.56)
β	-7.51	-8.07**	-0.001
	(4.91)	(3.80)	(0.004)
	PANEL C: 1-4 months before the election		
ρ	0.14	0.19	-0.78
	(0.35)	(0.32)	(0.56)
β	-13.01**	-12.77**	-0.0003
	(6.45)	(4.98)	(0.005)
	PANEL D: 0-3 months before the election		
ρ	0.12	0.17	-0.81
	(0.35)	(0.33)	(0.56)
β	-14.57**	-15.15***	0.007
	(6.66)	(5.13)	(0.005)
Observations	250	250	250
Year & Spatial Fixed Effects	Yes	Yes	Yes

Note. Each column represents a separate panel regression for the mayor elections. Panels A, B, C, and D report 3-month windows over the period [M-K-3, M-K] before elections. V.Incumbent, M.Victory, and Turnout are, respectively, total number of votes for the incumbent, the margin of victory of the incumbent, and the voter turnout. ρ is the spatial lag of the dependent variable. β measures the marginal effect of effectiveness variable (defined as the total time spent to fix potholes divided by the area of municipality over the three months window before election). Robust Standard errors in parentheses.$^{*}p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5 shows the estimation results. We see that controlling for the municipality- and year-fixed effects and the spatial dependence of electoral outcomes, each additional day of pothole management per square kilometer is associated with a decline of 7 to 14 votes for the incumbent, and 8 to 15 votes decline in the margin of victory. However, the statistical significance of votes for the incumbent diminishes as the time window gets further from the elections' date. As with other regressions, voter turnout is not statistically significant. Without fully claiming causal linkage, these results nonetheless provide strong support to performance-based connection between digital participation and electoral support for the incumbent. Voters in Moscow seem to vote rationally and credit the relevant authorities responsible for effective governance in specific policy areas. Road quality matters for millions of commuters in urban Moscow.[22] The quick repair of each pothole – that is presumably noted by hundreds and thousands of Moscovites who pass them on their walk, run or ride to work, etc. – represents an important signal that the city has its *khozyain* (an effective administrator) who cares and who can ensure the timely fixing of city problems. Therefore, each pothole complaint provides the city government with an opportunity to demonstrate *effective performance* to hundreds and, in some cases, thousands of city residents. Such demonstrated performance, we argue, produces electoral support and works to legitimize the incumbent city authorities.

Sergei Sobyanin has invested massive resources into Moscow's transport and other city infrastructure aimed at improving urban life. Besides transport and roads, the city invests in parks, sidewalks, bicycle lanes, housing renovation, and other city 'beautification' projects. Over the last decade, the city spent as much money on urban renewal as the rest of the country combined.[23] Our findings reveal that these investments appear to have important electoral implications for Moscow's mayor.

But can Moscow's experience be transferred to other Russian regions or even to the national scale? Arguably, the most important condition for making this governance mechanism work is Moscow's affluence. As noted by Natalia Zubarevich, a highly respected expert on Russian regions, 'Moscow is not just rich; it is filthy rich!" (Zubarevich 2019). Moscow is unique in Russia because it benefits from the profit tax revenues of the majority of Russia's large banks and state-owned corporations. The highest paying jobs and, therefore, the personal income tax revenues are also the biggest in Moscow. No other federal subject in the Russian Federation has such enormous financial resources to invest in transport infrastructure and road maintenance at such a scale. Nonetheless, there are signs that other regional governments in Russia are aware of the political dividends of investing in digital and physical infrastructure and lobby the federal government for additional resources to capture those dividends (Sharafutdinova 2013). In his 2020 annual address to the Federal Assembly, the Russian President Vladimir Putin had also highlighted the investments in transport infrastructure nationwide as one of the federal government's priorities.[24]

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[22] According to a recent poll by one of Russia's leading polling agencies, Levada Center, roads and transportation (congestion, parking, and repairs), along with migration and health care were the most important issues of concern to Moscow residents, see https://www.kommersant.ru/doc/3984374 [last accessed: September 2020].

[23] https://www.themoscowtimes.com/2019/12/13/moscows-urban-renewal-budget-equals-rest-russias-a68613 [last accessed: September 2020]. For alternative arguments on the underlying motives, see Trubina (2020).

[24] http://kremlin.ru/events/president/news/62582 [last accessed: September 2020].

Our findings indicate that local governments can select issue areas of high salience for the voters to demonstrate effective governance and ripping political rewards. The case of road management and digital engagement in Moscow city demonstrates that 'selective responsiveness' that benefits politicians in China is also a mechanism used in other electoral contexts. It also alerts to the fact that authorities can avoid more complex issue areas (such as the education sphere or healthcare systems) that require greater institutional effort, more time, and human capital for development and gain political advantage by focusing on highly visible (literally) issues such as pothole repair to gain electoral support. Such selectiveness might not be unique to authoritarian and electoral authoritarian regimes, as recent theoretical explorations of visibility in public goods provision in more competitive political systems reveal (Mani and Mukand 2007).

Conclusions

Potholes can help the incumbent city government stay in power if they are filled in a timely way. This is an intriguing new finding that emerges from this study. We took advantage of a publicly salient policy sphere – road quality – in Moscow (the capital city of Russia) to explore the use of digital technologies as means of aggregating information and demonstrating the government's capacity and effectiveness. We focus on the potential linkage between the road quality based on citizens' complaints and the electoral outcomes in two rounds of Moscow mayoral elections in 2013 and 2018. We establish the causal relationship between these two processes making use of arguably exogenous variation in the differences across local weather conditions (temperature, precipitation) during the heating season that differentially affects pothole creation but is uncorrelated with electoral outcomes. Our results indicate that greater use of digital technologies (measured by potholes complaints) results in an increased number of votes and a higher margin of victory for the incumbent. These results are consistent with the recent literature on responsive and consultative authoritarianism. They highlight the role of digital technologies as a tool the authorities use to create participatory governance mechanisms and convey to the public an image of a transparent, responsive, and capable government.

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Appendix

Calculation of municipal-level estimates of daily temperature switch and precipitation instances

We use kriging, a spatial interpolation method, to estimate temperature and precipitation across 125 municipalities. The daily weather data come from 13 weather stations shown in Table A.3 over 01/11/2009 - 01/12/2019. The data include information on temperature and precipitation. The differences in altitude between the stations are small and do not exceed 100 meters. This ensures that our calculation of weather variables is not affected by elevation. We also find no systematic differences in meteorological estimates across stations.

The formula for the kriging method is:

$$Z'(s_0) = \sum_{n=1}^{N} \mu_n \, Z(s_n)$$

where:

Z(sn) is the measured value at the i-th location, μ is an unknown weight for the measured value at the *n*-th location (depends on the distance between the measured points and the prediction location as well as the overall spatial arrangement of the measured points, s_0 is the prediction location and N is the number of measure values.[25]

We use ArcMap model builder tools for daily kriging estimations. This provides us weather data that not only vary across municipalities but also vary within the municipality. We calculate daily mean temperature and precipitation values for each of 125 municipalities using the zonal statistics tool and Moscow municipality shapefile available from GIS-Lab, the largest geospatial open-source data collection collected by the informal community of Russian-speaking GIS/RS specialists.[26] We calculate the temperature switch measure based on observed consecutive day changes in the temperature from below 0 °C to above °C and vice versa. It is a dummy variable, which takes the value of 1 if we observe a switch in the sign of temperature within consecutive days. We then

[25] https://desktop.arcgis.com/en/arcmap/10.3/tools/3d-analyst-toolbox/how-kriging-works.htm

[26] https://gis-lab.info/qa/moscow-atd.html

calculate an indicator variable for the observed switch in the temperature and instances of precipitation. Finally, we collapse the data at the month-municipal level to measure the total number of instances.

Tables

Table A.1. Descriptive Statistics

Variable	Year	N	Mean	St. Dev.	Min	Max
Pothole Complaints (cumulative)						
6 months before elections	2013 & 2018	250	117.4	117.5	0	680
5 months before elections	2013 & 2018	250	102.9	106.1	0	635
4 months before elections	2013 & 2018	250	66.7	75.0	0	376
3 months before elections	2013 & 2018	250	41.4	47.4	0	251
Votes for the Incumbent	2013 & 2018	250	10,615	5,748	295	42,401
Margin of Victory	2013 & 2018	250	7,165	5,284	-218	37,168
Voter Turnout	2013 & 2018	250	33.4	4.96	21.2	50.2
Pothole Complaints (cumulative)						
6 months before elections	2013	125	42.5	38.3	0	264
5 months before elections	2013	125	34.8	32.5	0	227
4 months before elections	2013	125	16.0	15.4	0	92
3 months before elections	2013	125	11.1	11.5	0	68
Votes for the Incumbent	2013	125	9,061	4,643	295	27,693
Margin of Victory	2013	125	4,171	2,846	-218	15,568
Voter Turnout	2013	125	33.9	4.79	21.2	46.9
Pothole Complaints (cumulative)						
6 months before elections	2018	125	192.3	122.3	0	680
5 months before elections	2018	125	171.0	110.4	0	635
4 months before elections	2018	125	117.4	76.6	0	376
3 months before elections	2018	125	71.8	50.3	0	251
Votes for the Incumbent	2018	125	12,168	6,318	2,232	42,401
Margin of Victory	2018	125	10,157	5,468	1,794	37,168
Voter Turnout	2018	125	32.9	5.08	25.39	50.2

Table A.2. Heating Season, 2012-2019

Year	Heating Season
2012	January 1-April 19 & 14 October –31 December
2013	1 January- 3 May & September 30-December 31
2014	1 January- 22 April & 7 October- 31 December
2015	1 January- 30 April & October 12-December 31
2016	January 1-April 28 & September 16-December 31
2017	1 January- 3 May & October 25-December 31
2018	January 1-April 19 & October 26-December 31
2019	January 1-April 24 & 26 September -31 December

Note: This table shows the heating season in Moscow for the period 2012-2019. We use VDNKH Station, which is the main weather station, data to decide Heating vs Non-Heating Season period.

Table A.3. List of Weather Stations

Stations	Latitude	Longitude	Altitude(m)
Balchug Station	55.74	37.63	186
Domodedovo Airport	55.41	37.90	156
Lenin Gorky	55.50	37.77	166
Mikhailovskoe	55.37	37.20	192
Mikhnevo	55.13	37.96	178
Naro Fominsk	55.38	36.70	193
New Jerusalem	55.90	36.82	146
Ostafyevo	55.49	37.50	155
Sheremetyevo Airport	55.97	37.41	181
Tushino	55.87	37.43	171
Vdnkh	55.83	37.62	172
Vnukovo Airport	55.60	37.27	202
Zhukovski Airport	55.56	38.11	120

Table A.4: Effect of Digital Public Engagement on Electoral Competition
(With Spatial Lags of Explanatory and Instrumental Variables)

Dependent variable:	N.Complaints	V.Incumbent	M.Victory	Turnout
GMM Stage:	I	II	II	II
PANEL A: 3-6 months before the election				
ρ_X	-1.07**	-90.78***	-77.71***	0.01
	(0.53)	(19.6)	(15.36)	(0.02)
ρ_{IV}	2.82**			
	(1.17)			
β_{IV}	5.47**			
	(2.28)			
ρ		0.61	0.76	1.48
		(0.64)	(0.62)	(1.76)
β		41.13***	27.85***	-0.003
		(7.49)	(5.87)	(0.007)
Wald Test χ^2 $(p-val)$	5.75 (0.01)			
PANEL B: 2-5 months before the election				
ρ_X	-1.08**	-85.58***	-73.47***	0.01
	(0.52)	(18.52)	(14.45)	(0.01)
ρ_{IV}	3.03**			
	(1.23)			
β_{IV}	4.82**			
	(2.39)			
ρ		0.62	0.75	1.47
		(0.65)	(0.62)	(1.75)
β		38.61***	26.53 ***	-0.003
		(7.19)	(5.62)	(0.007)
Wald χ^2 (p)	6.04 (0.01)			
PANEL C: 1-4 months before the election				
ρ_X	-1.05**	-111.11***	-97.23***	0.01
	(0.50)	(26.08)	(20.19)	(0.02)
ρ_{IV}	1.92**			
	(0.87)			
β_{IV}	2.28			
	(1.70)			
ρ		0.86	0.84	1.51
		(0.65)	(0.61)	(1.68)
β		52.18***	36.73***	-0.009
		(10.32)	(8.00)	(0.01)
Wald χ^2 (p)	4.80 (0.02)			
PANEL D: 0-3 months before the election				
ρ_X	-0.36	-150.31***	-131.35***	0.02
	(0.43)	(34.66)	(26.78)	(0.03)
ρ_{IV}	2.40***			
	(0.70)			
β_{IV}	1.11			
	(1.37)			
ρ		0.58	0.62	1.88
		(0.66)	(0.62)	(1.65)
β		59.14***	40.68***	-0.007
		(12.88)	(9.97)	(0.013)
Wald Test χ^2 (p)	11.55 (0.00)			
Observations	250	250	250	250
Year & Spatial Fixed Effects	Yes	Yes	Yes	Yes

Note. Each column represents a separate regression. Panels A, B, C, and D report 3-month windows over the period [M-K-3, M-K] before elections. N.Complaints is the number of cumulative digital potholes complaints over the three months window before elections. V.Incumbent, M.Victory, and Turnout are, respectively, total number of votes for the incumbent, the margin of victory of the incumbent, and the voter turnout. ρ_X indicates the spatial lag of digital pothole complaints. ρ_{IV} is the spatial lag of the instrumental variable defined in equation (2). β_{IV} is the marginal effect of the instrumental variable. ρ is the spatial lag of the dependent variable in the regression second-stage. β measures the marginal effect of digital public engagement (proxied by digital pothole complaints). The Wald test χ^2 (p-value in parentheses) measures the joint significance of the excluded instruments. Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Effect of Digital Public Engagement on Electoral Competition: Excluding Main Roads

Dependent variable:	N.Complaints	V.Incumbent	M.Victory	Turnout
GMM Stage:	I	II	II	II
PANEL A: 3-6 months before the election				
ρ_X	-0.95			
	(0.52)			
β_{IV}	8.32***			
	(1.92)			
ρ		0.92	0.73	2.82*
		(0.93)	(0.90)	(1.70)
β		29.85***	17.85***	-0.004
		(8.14)	(6.45)	(0.008)
Wald χ^2 (p)	18.7 (0.00)			
PANEL B: 2-5 months before the election				
ρ_X	-0.81			
	(0.49)			
β_{IV}	7.87***			
	(2.04)			
ρ		1.23	1.15	2.80*
		(0.75)	(0.73)	(1.68)
β		27.70***	16.97***	-0.004
		(7.78)	(6.15)	(0.007)
Wald χ^2 (p)	14.86 (0.00)			
PANEL C: 1-4 months before the election				
ρ_X	-0.68			
	(0.46)			
β_{IV}	4.20***			
	(1.83)			
ρ		1.07	1.05	2.65
		(0.71)	(0.70)	(1.63)
β		39.94***	25.66***	-0.01
		(11.27)	(8.87)	(0.01)
Wald χ^2 (p)	8.66 (0.00)			
PANEL D: 0-3 months before the election				
ρ_X	-0.25			
	(0.41)			
β_{IV}	3.43***			
	(1.14)			
ρ		0.80	0.85	2.55
		(0.71)	(0.69)	(1.65)
β		43.35***	26.33**	-0.009
		(14.18)	(11.17)	(0.01)
Wald χ^2 (p)	8.94 (0.00)			
Observations	250	250	250	250
Year & Spatial Fixed Effects	Yes	Yes	Yes	Yes
Exclude Main Roads	Yes	Yes	Yes	Yes

Note. Each column represents a separate regression. Panels A, B, C, and D report 3-month windows over the period [M-K-3, M-K] before elections. N.Complaints is the number of cumulative digital potholes complaints over the three months window before elections. V.Incumbent, M.Victory, and Turnout are, respectively, total number of votes for the incumbent, the margin of victory of the incumbent, and the voter turnout. ρ_X indicates the spatial lag of complaints in the regression first stage. β_{IV} is the marginal effect of the instrumental variable defined in equation (2). ρ is the spatial lag of the dependent variable in the regression second-stage. β measures the marginal effect of digital public engagement (proxied by digital pothole complaints). The Wald test χ^2 (p-value in parentheses) measures the joint significance of the excluded instruments. Robust Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Balancing Test: Instrumental Variable, 2013 and 2018

Dependent variable: Instrumental variable	Coefficient (standard error)	t-statistics (p-value)	N.Obs.	Fixed Effects Year(Y), Municipality(M)
PANEL A: Geophysical and Infrastructure Indicators				
Total municipal area (thousand sq. kilometers)	-11.02 (8.85)	-1.25 (0.21)	250	Y
Total residential area (thousand sq. kilometers)	-2.63 (4.74)	-0.56 (0.58)	250	Y,M
Total length of streets, driveways and embankments (km)	0.003 (0.002)	1.51 (0.13)	250	Y,M
Air Pollutant Emissions (tons)	-0.51 (1.15)	-0.45 (0.65)	219	Y,M
PANEL B: Economic and Fiscal Indicators				
Municipal budget revenues (rubles)	0.01 (0.02)	0.67 (0.50)	250	Y,M
Average monthly salary (per thousand rubles)	0.001 (0.001)	1.21 (0.22)	250	Y,M
PANEL C: Demographic and Social Indicators				
Total birth rate	-0.02 (0.03)	-0.72 (0.47)	250	Y,M
Total death rate	0.01 (0.01)	0.91 (0.36)	250	Y,M
Migration growth rate	-0.001 (0.001)	-1.62 (0.10)	250	Y,M
Number of residents in dilapidated buildings (per thousand)	0.19 (0.33)	0.58 (0.56)	143	Y,M
Number of families requested social housing	-0.004 (0.008)	-0.52 (0.60)	250	Y,M
Number of families received social housing	-0.004 (0.03)	-0.14 (0.89)	250	Y,M
Population density (people per sq. meter)	-20.2 (18.01)	-1.12 (0.26)	250	Y,M

Note. Each row represents a separate panel regression of the dependent instrumental variable defined on p. 14 and the balancing indicator shown in that row. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.7: Balancing Test: Online Platforms, 2013

Dependent variable:	V.Incumbent	M.Victory	Turnout
ShareRosyama	0.77	-8.87	-0.009
(standard error)	(16.57)	(10.37)	(0.01)
t-statistic (p-value)	0.05 (0.96)	-0.86 (0.39)	-0.49 (0.62)
Observations	125	125	125
Control for Log Area	Yes	Yes	Yes

Note. Each column represents a separate regression. V.Incumbent, M.Victory, and Turnout are, respectively, total number of votes for the incumbent, the margin of victory of the incumbent, and the voter turnout in 2013. *ShareRosyama* indicates the share of pothole complaints reported by *Rosyama* application.