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Infrastructure investments and entrepreneurial dynamism in the U.S.

Daniel L. Bennett[1]

Baugh Center for Entrepreneurship & Free Enterprise, Baylor University, One Bear Place #98011, Waco, TX 76798, United States of America

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ABSTRACT

Investments in physical infrastructure induce environmental changes that serve both an enabling and disabling function, potentially acting to simultaneously stimulate new business establishment and provoke exit by some incumbent establishments. The opening of a new establishment results in the creation of jobs that did not previously exist. Similarly, the closing of an establishment results in the permanent loss of jobs. I develop a theoretical model that depicts this external enabler/disabler process and test the model's predictions empirically tested using annual state-level data spanning the period 1993–2015. The results from dynamic panel system GMM estimation suggest that public and private infrastructure investments exert opposite effects on dynamism. Whereas private infrastructure investment is positively and significantly associated with the creation of businesses and jobs, public infrastructure investments are associated with the destruction of businesses and jobs. These results point to private infrastructure investment serving primarily an entrepreneurial enabler role and public infrastructure investment an entrepreneurial disabler role.

Executive summary

Scholars are increasingly interested in how the environmental context affects entrepreneurial activity across regions (Fritsch and Storey, 2014; Sternberg, 2009). One aspect of the environment that has received sparse attention is investment in physical infrastructure development. Audretsch et al. (2015, p. 226), authors of the only study to explicitly explore the relationship between physical infrastructure and entrepreneurship, found that regional start-up activity is positively and significantly associated with physical infrastructure within the context of Germany. They concluded by declaring, “infrastructure may be one of the most overlooked influences of entrepreneurial activity.” In this paper, I fill several gaps in this infant literature.

First, I develop a theoretical framework linking infrastructure development to entrepreneurship that considers the potential for infrastructure development to both stimulate entrepreneurial action and adversely affect incumbent businesses. Building on the external enabler concept (Davidsson, 2015), my model links changes in the external environment such as those engendered by infrastructure investments to the enablement and disablement of entrepreneurial opportunities, which manifest as the creation and destruction of business establishments and jobs associated with their operation. My framework predicts that infrastructure investments will serve both an enabling and disabling role, encouraging business entry and exit as well as the organic creation of new jobs and the permanent destruction of jobs.

Second, I account for the cost of developing infrastructure. Audretsch et al. (2015) focused on the presence or quantity of infrastructure in place, but given that advanced economies already have significant infrastructure in place, the cost of new

E-mail address: bennettecon@gmail.com.
[1] Website: www.bennettecon.com.

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infrastructure investments and their marginal impact on entrepreneurial activity are also important policy considerations. I therefore use annual U.S. state-level infrastructure investment per capita data over the period 1992–2015 to empirically test the predictions that infrastructure investments lead to both the creation and destruction of business and jobs.

Lastly, while the analysis by Audretsch et al. (2015) focused on publicly-owned infrastructure, I account for the roles of both publicly and privately developed infrastructure in the entrepreneurial process. Using dynamic panel system Generalized Methods of Moments (GMM) estimation, my results suggest that public and private infrastructure investments exert opposing effects. Private infrastructure investment positively benefits business and job creation, while public infrastructure investment eliminates businesses and jobs, pointing to private infrastructure investment serving primarily an enabling role and public infrastructure investment a disabling role. To the extent that policymakers want to encourage the creation of new businesses and stimulate organic job growth, public infrastructure investments are unlikely to satisfy this objective. Instead, public infrastructure investments may adversely affect some incumbent businesses, potentially acting to permanently destroy jobs. Policies that encourage (or at least do not deter) private infrastructure investments are more likely to encourage new business creation and job growth. My results may also have implications for the location decisions of entrepreneurs, particularly those whose ventures are heavily reliant on transportation infrastructure to move goods and entrepreneurial firms entering the growth stage that face local resource constraints.

1. Introduction

Entrepreneurship scholars are increasingly interested in how region-specific cultural, demographic, economic, political, and social factors (Spigel, 2017; Stam, 2015), which are largely beyond the control of individual agents (Drucker, 2014), impact entrepreneurial activity (Fritsch and Storey, 2014; Sternberg, 2009). Such phenomenon have recently been described as external enablers (Davidsson, 2015; Davidsson et al., 2018); however, prospective as well as current entrepreneurs are dependent on the environment in which they operate such that changes in the environment will influence their actions (Pfeffer and Salancik, 2003). Indeed, a growing body of research suggests that the regional context or environmental conditions influence business formation (e.g., Bartik, 1989; Feldman, 2001; Fritsch and Storey, 2014; Reynolds et al., 1994) and business exit rates (e.g., Campbell et al., 2012; Reynolds et al., 1995).

While there are many types of environmental shifts that can trigger entrepreneurial dynamism, or the creation and destruction of businesses, one that has received very little scholarly attention is investments in physical infrastructure development. In the only study to explicitly explore the relationship between infrastructure and entrepreneurship, Audretsch et al. (2015) found that, within the context of Germany, regional start-up activity is positively and significantly associated with railway and broadband infrastructure, but highway infrastructure has no effect. Audretsch et al. (2015, p. 226) concluded by suggesting, “infrastructure may be one of the most overlooked influences of entrepreneurial activity.”

This an area of critical neglect because investments in infrastructure development and the environmental changes they engender to a region are likely to impact the actions of current and prospective entrepreneurs, thereby serving an Environmental Enabler and Disabler (EED) role (Davidsson, 2015; Wood and Mckinley, 2017). Indeed, physical infrastructure has been identified as an important element of the regional entrepreneurial environment (Audretsch et al., 2012; Spigel, 2017; Stam, 2015) and environmental changes can either stimulate or impede entrepreneurship in a region (Sternberg, 2009; Van De Ven, 1993).

I seek to shed light on this possibility by theorizing that investments in infrastructure create changes in the physical environment that may act to both enable and disable opportunities for entrepreneurs. Given the well-documented ambiguity over the entrepreneurial opportunity construct (e.g., Foss and Klein, 2018; McMullen et al., 2007), I contend that these occurrences manifest as new establishment entry and extant establishment exit, as the result of investments in infrastructure development. Therefore, the primary research question that I address is: *Do investments in infrastructure create and destroy opportunities as indicated by establishment entry and establishment exit rates*?

To the extent that infrastructure investments enable new business entry, this will result in the organic creation of new jobs by market entrants. On the other hand, infrastructure investments that disable incumbent businesses will permanently destroy jobs. To further investigate infrastructure investment's impact on dynamism, I also address the following research question: *Do investments in infrastructure create new jobs and destroy existing ones as indicated by the birth job creation and death job destruction rates*? Furthermore, I examine whether the source of infrastructure investment (i.e., public versus private sector) matters.

Audretsch et al. (2015) focused on the presence or quantity of infrastructure in place. While an important public policy consideration, given that advanced economies such as Germany and the U.S. have well-developed infrastructure in place to support their modern market economies, the cost of developing new infrastructure and its marginal impact on entrepreneurial activity are also relevant public policy considerations. Additionally, Audretsch et al. (2015) consider only the effects of public infrastructure on startup activity. Private infrastructure investments also play a role in this process and environmental changes such as those engendered by infrastructure investments may, in addition to stimulating firm and job creation, act to displace incumbent businesses and the people they employ.

I attempt to fill some of these gaps in this infant literature in several ways. First, I develop an EED model that links changes in the regional environment induced by infrastructure investment to the creation and destruction of businesses and jobs, as described in Section 2. I hypothesize that infrastructure investments are associated with higher establishment entry and higher exit rates,[2] as well

[2] Environmental factors such as infrastructure differ across regions and change gradually over time, thereby shaping the extent of entrepreneurship within a region, motivating the use of regionally aggregated measures (Audretsch et al., 2012) at the state-level as appropriate proxies for creation and destruction.

as higher birth job creation and higher death job destruction rates. Next, I consider the potentially differential impact of private and public sector infrastructure investments on dynamism. Lastly, I test the hypotheses empirically using dynamic panel System GMM estimation and state-level panel data, as described in Section 3. My empirical results, presented in Section 4, suggest that private and public infrastructure investments exert opposite effects on dynamism, with private investments benefiting business and job creation and public investments eliminating businesses and jobs. I discuss the results in Section 5.

2. Conceptual framework & theory

2.1. Entrepreneurial dynamism

Dynamism serves as a market mechanism in which entrepreneurs efficiently reallocate capital and labor resources from less to more productive uses (Decker et al., 2014; Hathaway and Litan, 2014). It is an intrinsic property of the entrepreneurial ecology (Phan, 2006) in capitalistic economies that serves as a proxy for adaptability, or an economy's ability to respond effectively to exogenous change in an increasingly competitive global economy (EIG, 2017). Schumpeter (1942) described the process of creative destruction, which acts to reallocate resources to their highest valued use, as the essential fact of capitalism. That is, dynamic capitalistic economies are characterized by substantial creation and destruction of businesses and jobs (Barnatchez and Lester, 2017) as "more productive firms drive out less productive ones, new entrants disrupt incumbents, and worker are better matched with firms (Hathaway and Litan, 2014, p. 1)," promoting the productivity gains and innovation necessary to sustain economic growth and generate new jobs in the economy (Decker et al., 2014, 2016a).

Dynamism is a multi-dimensional concept that I treat as two distinct latent constructs: (1) Creation, and (2) Destruction. I consider two observable aspects of dynamism for each construct that reflect opposite processes. First is the creation and destruction of business establishments. Business establishments are an appropriate unit of analysis because the competitive impact of an environmental change on competition within a region may be actualized in the form of a new firm entering the market, the creation of a new business by an existing firm, or the expansion of an existing firm into a new market via a new establishment location (Kirchhoff, 1994).[3] Second is the creation and destruction of jobs associated with the entry and exit of establishments, respectively. When a new establishment enters the market, it creates jobs that did not previously exist. When an existing establishment exits the market, the jobs associated with running it cease to exist.[4]

2.2. Infrastructure investment

Infrastructure consists of large-scale capital projects that require substantial sunk and irreversible financial investments to develop (Aschauer, 1989b; Audretsch et al., 2015). A region's fundamental facilities, structures and systems that facilitate economic represent its infrastructure. This includes a variety of capital goods that serve as the basic framework, that broadly supports commercial activities and the provision of public services, including goods whose functional purpose is to: facilitate the transportation of people and goods (e.g., airports, highways, seaports); distribute power and other essential utilities to commercial, public and residential areas (e.g., power plants, water treatment facilities, sewers); support the provision of education, health, justice and other human services (e.g., courts, hospitals, police stations, schools); and/or facilitate the production and/or exchange of goods and services (e.g., factories, industrial parks, office buildings, shopping malls).[5]

Because infrastructure often resembles a natural monopoly, provision by a single supplier may be optimal from an efficiency standpoint (Audretsch et al., 2015; Gramlich, 1994). This, combined with the potential for infrastructure generate positive externalities benefitting private parties not directly bearing its costs of development (Conrad and Seitz, 1994; Pereira and Andraz, 2013), is often cited as the rationale for government to be the sole provider. Along these lines, Audretsch et al. (2015) made a distinction between large capital projects according to whether the investor is a private firm or government, suggesting that the former represents a capital and the latter an infrastructure project.

I also make a distinction based on the source of infrastructure investment, but adopt a broader view that allows for private provision based on the notion that a profit-maximizing firm will invest in infrastructure projects for which the total expected private benefits exceed the total expected private costs, even if some of the benefits spillover to other parties. Indeed, private firms often invest in infrastructure as a means to decrease delivery times, enhance productive capacity, improve manufacturing quality and/or lower production costs (Miller, 2013). Further, I focus on the cost of new infrastructure development rather than the existing quantity or stock of infrastructure because the latter of represents an accumulation of past investments over a long time period. In doing so, I

[3] I do not make a distinction between these different types of business formation (or analogously, termination), all of which represent an entrepreneurial mode of entry (exit) into (out of) a regional market in response to a change in the external environment (Harvey and Evans, 1995), in the development of the theoretical model or the empirical analysis. With respect to exits, I do not distinguish between those attributable to failure and those for which exit is voluntary (Detienne and Wennberg, 2014).

[4] My data distinguishes between jobs created by new establishments and those destroyed by exiting establishments, but it does not account for job creation and destruction by the expansion and contraction, respectively, of incumbent establishments. The latter may also be triggered by changes in the external environmental, but it is the jobs created and destroyed by entering and exiting establishments, respectively, that mostly closely aligns with the creative destruction process that I seek to examine. Additional results provided in Section 4.3, however, examine the impact of infrastructure investments on total job creation and destruction.

[5] Miller (2013) provides a similarly broad definition of infrastructure.

adopt a dynamic view of the process by which infrastructure development alters the external environment faced by current and prospective entrepreneurs, as well as provide policy guidance concerning the marginal effects of new infrastructure investments.

2.3. External Enabler/Disabler (EED) framework

Opportunities are the lifeblood of entrepreneurial activity. Whether conceptualized as the introduction of new goods or services (Shane and Venkataraman, 2000), entry into new markets (Lumpkin and Dess, 1996) or the creation of new ventures (Gartner, 1985), it is the active pursuit of opportunities that stimulate a cascade of economic change. While the origins of opportunities are a source of intense debate (e.g., Alvarez and Barney, 2007; Davidsson, 2017; McMullen et al., 2007; Ramoglou and Tsang, 2016), there is no denying that changes in one's external environment can, at a minimum, stimulate perceptions of opportunity that evoke entrepreneurial action (Dimov, 2011; Shane and Venkataraman, 2000; Wood and McKinley, 2010). In an effort to re-conceptualize opportunity dynamics, Davidsson (2015, p. 683) described how "external enablers," or external circumstances such as changes in technology or institutional framework conditions, play a central role in "eliciting and/or enabling a variety of entrepreneurial endeavors by several (potential) actors."

Although Davidsson focused on the opportunity-enabling function of external circumstances, he also noted that external enablers are transient. That is, external conditions such as demographics, institutional framework conditions, public policy and technology are subject to change. Such transformation of the economic system may act to erode the existence of an external enabler or its enabling capacity (Davidsson, 2015), ultimately shifting what was once a condition that fueled an opportunity into a disabling condition for its continuation, particularly when maintenance of an opportunity does not keep pace with environmental change (Wood and Mckinley, 2017). This suggests that, changes in external circumstances serve as a triggering event (Moore, 1986) that can enable as well as erode or destroy entrepreneurial opportunities (Covin and Slevin, 1991; Van De Ven, 1993).

This line of thinking parallels the logic behind the concept of "window of opportunity" that reflects the finite nature of competitive market imperfections in the sense that there is an optimal time and place for market receptiveness to specific offerings (Harvey and Evans, 1995). In other words, entrepreneurs and firms have a limited period of time to act on unexploited market opportunities for which they have the competencies to satisfy (Abell, 1978; Kirzner, 1973). Juxtaposed with the idea of external enablers, what emerges is a world where shifts in the environment create enabling conditions that "open the window" for some opportunities, while at the same time engender disabling conditions that "close the window" on other opportunities (Abell, 1978). As far back of Schumpeter (1934), scholars have been aware of the creative and destructive nature of environmental shifts, and entrepreneurs in the field often develop alert antenna capable of detecting such patterns of change (Baron, 2000; Kirzner, 1979). Investigations of these phenomena fall under the umbrella of entrepreneurial dynamism in which changes in the environment stimulate entry of new and innovative companies and drive older less productive firms to exit (Detienne and Wennberg, 2014; Phan, 2006; Schumpeter, 1942), as prospective and current entrepreneurs react to environmentally-induced changes in the relative costs and benefits of alternative uses of their resources (Drucker, 2014).

Because opportunities are elusive entities (Foss and Klein, 2018; McMullen et al., 2007), I contend that they manifest in the form of new establishment entry and extant establishment exit, as the result of changes in the external environment. That is, environment changes may serve both an enabling and disabling function, simultaneously stimulating establishment entry and provoking establishment exit. The creation of a new establishment results in the creation of new jobs that did not previously exist. This suggests that the enabling function of environment shifts will also enable the creation of new jobs. Similarly, the destruction of an existing establishment entails the loss of existing jobs. The disabling role of environmental changes will therefore also lead to the permanent destruction of existing jobs. I depict this EED process in Fig. 1.

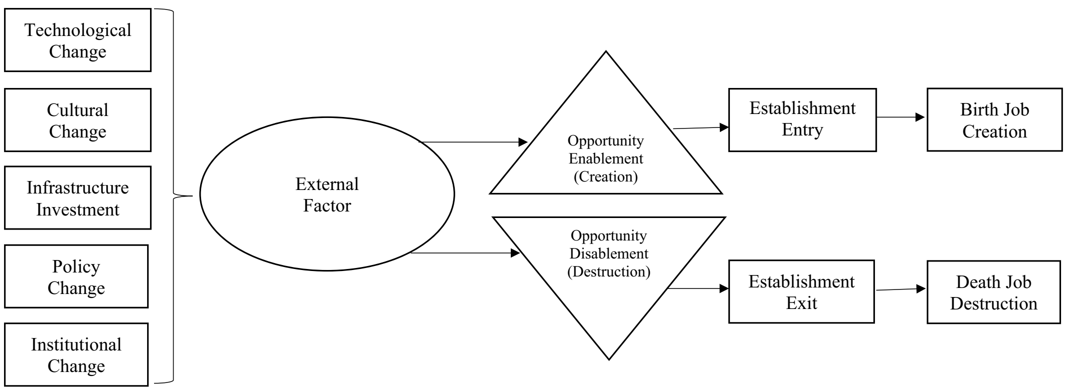

Fig. 1. External Enabler/Disabler (EED) model.

2.4. Infrastructure investment & dynamism

Despite being identified as an important element of the regional entrepreneurial environment (Audretsch et al., 2012; Spigel, 2017; Stam, 2015), the role of physical infrastructure development in the entrepreneurial process has received sparse attention (Audretsch et al., 2015). Investments in infrastructure and the environmental changes they engender are likely to impact the actions of entrepreneurs as they create changes in the physical environment that may act to both open and close opportunities for entrepreneurs (Abell, 1978; Harvey and Evans, 1995), thereby serving to both enable and disable entrepreneurial opportunities.

New infrastructure investments can help facilitate the flow of capital, goods, ideas and people (Audretsch et al., 2015), potentially acting to improve linkages within a region (Hirschman, 1988). As an external enabler, infrastructure investments "create room for new economic activities (Davidsson, 2015, p. 675)", supporting the development or expansion of growth centers, or the clustering of economic activity in a region (Moseley, 2013; Perroux, 1950). Incumbent businesses may strategically relocate to an infrastructure-enabled growth center, but the development of new infrastructure will also attract entry from risk taking and proactive entrepreneurs alert and ready to act on the exploitable opportunities that it enables (Covin and Slevin, 1991; Hirschman, 1988; Kirzner, 1973). In this way, infrastructure investments trigger a window of opportunity for entrepreneurs to act by establishing a new firm or expanding an existing firm into a new created or expanded market (Harvey and Evans, 1995). That is, entry may come in the form of a new business or the expansion of an existing firm via the creation of a new establishment in a location that it now perceives as a viable market to enter. In either case, infrastructure investments act to enable the creation of new business establishments.

While infrastructure investments may promote the growth and clustering of economic activity in a region in ways that enable new entrepreneurial opportunities, they also potentially serve a disabling function by adversely altering the environment for incumbent businesses located away from the growth center. It has been demonstrated, for instance, that infrastructure investments can result in polarized growth (Blum, 1982a, 1982b). The polarization effects induced by infrastructure development may prompt a redistribution of entrepreneurial opportunities from peripheral areas to the growth centers, as economic activity becomes increasingly geographically concentrated (Boarnet, 1998; Chandra and Thompson, 2000; Clay et al., 1992; Stephanedes, 1989).

In other words, the enablement of entrepreneurial opportunities from infrastructure investments in one area may come at the expense of the disablement of previously acted upon entrepreneurial opportunities in a peripheral area, resulting in the demise of incumbent establishments that do not adapt to the changing environment by relocating their business or pursuing other strategic opportunity maintenance actions (Wood and Mckinley, 2017). The disabling effect may be particularly strong when infrastructure investments in a region encourage competition in the form of entry by national or global firms that benefit from considerable economies of scale and/or substantial brand recognition. Thus, infrastructure investments may create a window of opportunity that enables entry by new establishments while simultaneously acting to close windows for previously acted upon opportunities, resulting in establishment exits.

To provide a concrete example of the potential enabling and disabling roles of infrastructure investment, consider the development of a new highway bypass. While bypasses often reduce road congestion caused by traffic traveling through a city and improves travel times for through traffic, the opening of a bypass redirects traffic away from the traditional city center to the new highway and routes connecting to the bypass (Andersen et al., 1993; Kockelman et al., 2001). This creates a new growth center around the bypass and connecting routes that enables opportunities for entrepreneurs to create establishments that serve travelers in commute, resulting in a clustering of new retail and service establishments to better capture the business of visitors and transients (Clay et al., 1992). In addition to enabling opportunities for retail and service sector businesses to locate near a bypass to serve passing traffic (Chandra and Thompson, 2000; Thompson et al., 2001), a new highway may also reduce travel times and transport costs in the area. The lower transport costs, in conjunction with reduced commuting times for workers, may in turn increase the attractiveness of a community located near a highway to entrepreneurs in the industrial, manufacturing and wholesale sectors (Clay et al., 1992; Handy et al., 2001).

While the development of a new bypass may serve an enabling role by creating a growth center that results in the "blossoming of new businesses along the new highway (Handy et al., 2001, p. 1)", it may simultaneously serve a disabling role by adversely impacting incumbent businesses located away from the highway that depend to a large extent on passing traffic to sustain sales (Babcock and Davalos, 2004; Chandra and Thompson, 2000). Business owners and residents are often fearful that traffic reductions resulting from a new highway will entail the loss of customers and the decline of the traditional business center in their bypassed city (Babcock and Davalos, 2004; Handy et al., 2001). Such fears are not without merit. Previous research has found incumbent retail businesses that are traffic reliant –such as gas stations, hotels and restaurants –to be adversely impacted by the development of highway bypasses (Andersen et al., 1993; Chandra and Thompson, 2000; Kockelman et al., 2001; Otto and Anderson, 1993). The bypass therefore acts to disable some opportunities by redirecting the flow of potential customers away from incumbent businesses located in nearby areas. While some entrepreneurs may take action to maintain their opportunity by relocating their negatively affected business closer to the new highway or adjusting their product and service offerings, others will experience a withering of their business as new establishments positioned along or near the highway capture a greater share of the commuter market (Babcock and Davalos, 2004).

As this illustrative example suggests, investment in the development of new infrastructure may act to redistribute opportunities from one area to another, serving both an enabler and a disabler role. Similar redistributive mechanisms are at work with not only investments in transportation infrastructure, but also with the development of facilities, structures and systems that support the provision of commercial, educational, health, protective and other services vital to a well-functioning economy. Investments in the development of new hospitals, office buildings, shopping malls or schools, as well as the infrastructure structures and systems needed to support their operations, provide new locations for people to live and work, enabling the establishment of new businesses to serve the local community. The same growth center-inducing infrastructure investments may simultaneously serve a disabling function by drawing economic activity away from older nearby areas, adversely affecting some existing businesses located in the declining area. These opportunities manifest in the form of new establishment entry and extant establishment exit. I therefore propose the following hypotheses:

Hypothesis 1A. Infrastructure investments are positively associated with establishment entry rates.

Hypothesis 1B. Infrastructure investments are positively associated with establishment exit rates.

When a new establishment enters the market, it creates jobs that did not previously exist. As such, infrastructure investments that serve to enable new establishment entry will result in the creation of new jobs. Similarly, when an existing establishment exits the market the jobs associated with running it cease to exist permanently. Therefore, in their disabling role, infrastructure investments will result in the destruction of jobs. As such, I propose the following hypotheses:

Hypothesis 2A. Infrastructure investments are positively associated with job creation by new establishments.

Hypothesis 2B. Infrastructure investments are positively associated with job destruction by exiting establishments.

I examine the effects of both private and public infrastructure investments on dynamism. Public infrastructure investments decisions are made via the political process, based largely on political considerations, and financed through widely dispersed taxation. Meanwhile, private infrastructure investment decisions are made by entrepreneurs and firm managers, based largely on profit and loss considerations, and are privately financed. These differences between public and private infrastructure investments may lead to them generating differential impacts on the creation and destruction of businesses and jobs. I therefore test each of the above hypotheses separately for public and private infrastructure investments, but I do not formulate specific hypotheses concerning the effects of the two.[6]

3. Data & methodology

3.1. Empirical setting

My regional unit of analysis is the fifty U.S. states, which is appropriate for several reasons. First, most of the nation's public infrastructure is held by state and local governments and budgetary allocation decisions for public infrastructure projects are largely made at the state level (Gramlich, 1994; Leduc and Wilson, 2013).[7] Second, although infrastructure developed in one region of a state may appear to only direct effect entrepreneurs and firms located in close proximity to the development site, public infrastructure investments potentially impact entrepreneurs and firms located in regions remotely located from the development site through two mechanism: (i) Public infrastructure development reallocates economic activity across regions (Boarnet, 1998; Chandra and Thompson, 2000); and (ii) Public infrastructure investments are financed through taxation such that their development in one part of the state involves the reallocation of resources via taxation from entrepreneurs and firms in other parts of the state, who do not receive any of the benefits from it. Third, there is precedent in the regional entrepreneurship literature to use the state as the unit of analysis (Boudreaux et al., 2017; Campbell et al., 2012; Cumming and Li, 2013; Gohmann et al., 2008; Sobel, 2008; Xue and Klein, 2010).

In the remainder of this section, I describe the data utilized in the empirical analysis. A description of the variables and summary statistics are provided in Tables 1 and 2 presents pairwise correlations of the variables included in the main results.

3.2. Dynamism

Dynamism is my dependent variable (DV) that I conceptualize as two latent constructs. The first is *Creation*, which is measured by two observable variables: (i) The *Entry rate*, or the number of new establishments in period t as a share of all establishments, and (ii) the *Birth job creation* rate, or the ratio of employment gains from new establishments in period t to total employment in period $t\text{-}1$. The second, *Destruction*, is similarly measured by two separate observable variables that reflect the opposite process as the creation variables: (iii) the *Exit rate*, or the number of establishment exits as a share of all establishments, and (iv) the *Death job destruction* rate, or the ratio of employment losses from establishment closings in period t to total employment in period $t\text{-}1$. I obtained the dynamism measures from the Business Dynamics Statistics (BDS) database, which provides annual measures of business dynamics for the United States over the period 1976–2015. Due to limitations in the availability of other variables, I restrict the analysis to the period 1993–2015.

[6] My theory suggests that infrastructure investments engender environment changes that may serve both an enabling and disabling role, but it makes no distinction based on the source of the environmental change.

[7] The federal government is a source of finance for state infrastructure projects via block grants (Gramlich, 1990; Leduc and Wilson, 2013).

Table 1
Variable descriptions, summary statistics & sources.

Variable	Description	Mean	SD	Min	Max	*N*	Source
Entry rate	Number of new establishments as a share of all establishments.	10.99	2.04	6.70	19.20	1100	Business Dynamics Statistics
Birth job creation	Ratio of employment gains from new establishments in period t to total employment in period t-1.	5.48	1.28	2.90	9.60	1100	Business Dynamics Statistics
Exit rate	Number of establishment exits as a share of all establishments.	9.71	1.32	6.80	14.40	1100	Business Dynamics Statistics
Death job destruction	Ratio of employment losses from establishment closing in period t to total employment in period t-1.	4.52	1.00	2.40	9.10	1100	Business Dynamics Statistics
Net entry	Difference between Entry rate and Exit Rate.	1.28	1.49	−4.20	6.50	1100	Business Dynamics Statistics
Net job creation	Difference between birth job creation and death job destruction.	0.96	0.80	−3.80	4.10	1100	Business Dynamics Statistics
Total job creation	Ratio of employment gains from business expansion and entry in period t to total employment in period t-1.	15.09	2.44	9.20	23.00	1100	Business Dynamics Statistics
Total job destruction	Ratio of employment losses from contracting establishments and exits in period t to total employment in period t-1.	13.48	2.12	8.80	22.40	1100	Business Dynamics Statistics
Net total job creation	Difference between Job creation and Job destruction.	1.61	2.36	−9.70	8.60	1100	Business Dynamics Statistics
Private infrastructure investment	Real per capita private nonresidential construction expenditures ($100 s). Includes buildings and structures for lodging, offices, commercial industries, healthcare, private education, religious organizations, amusement and recreation, transportation, and manufacturing facilities. Also includes private public safety, non-railroad transportation, highway and street, sewage and waste disposal, water supply, and conservation and development infrastructure projects. Excludes private infrastructure projects in the power, communication, and railroad sectors.	9.59	5.13	1.22	52.49	1100	U.S. Census Bureau, Private Construction Spending
Public infrastructure investment	Total public infrastructure spending ($100 s) per capita, measured as sum of construction expenditures (F) and purchase of land and existing structures.	11.09	4.50	4.18	41.61	1100	U.S. Census Bureau, State and Local Government Finance Surveys
Corruption	Federal public corruption convictions (lagged on period) per 1 million persons.	3.33	3.00	0.00	29.36	1100	Reports to Congress on the Activities and Operations of the Public Integrity Section for 2002, 2007, and 2015
Citizen ideology	State citizen ideology, measured on 0–100 scale with 0 = most conservative and 100 = most liberal.	50.25	15.25	8.45	95.97	1100	Berry et al. (1998), revised 1960–2013 citizen ideology series.
Government consumption index	Government consumption spending index, measured on 0–10 scale with higher scores reflecting more government spending. Subnational EFNA area 1 (Government Spending) index, which is derived from 3 variables: government consumption expenditures, transfers and subsidies, and insurance and retirement payments.	7.04	1.06	1.88	9.16	1100	Stansel et al. (2017)
Tax distortion index	Tax distortions index, measured on 0–10 scale with higher scores reflecting greater tax distortions. Reverse scale of subnational EFNA area 2 (Taxation) index, which is derived from 4 variables: income & payroll taxation, top marginal tax rates & income threshold, property & other taxation, and sales taxation.	3.42	0.77	0.66	5.63	1100	Stansel et al. (2017)
Labor market frictions index	Labor market friction index, measured on 0–10 scale with higher scores reflecting more labor market frictions. Reversed scale of subnational EFNA area 3 index, which is derived from 3 variables: minimum wage, government employment, and union density. Invert scale such that higher scores reflect more labor frictions.	3.08	0.66	1.34	5.15	1100	Stansel et al. (2017)
Economic growth	Growth rate of real GDP per capita.	1.51	2.67	−9.20	19.30	1100	Bureau of Economic Analysis

(*continued on next page*)

Table 1 (*continued*)

Variable	Description	Mean	SD	Min	Max	*N*	Source
GDP less infrastructure	Natural log of real GDP per capita, excluding total public infrastructure spending and private construction expenditures. In constant 2015 USD. Pre-1997 GDP calculations based on SIC industry, while post-1997 based on NAICs. Both series have value for 1997 so use the average of the two.	10.73	0.20	10.24	11.25	1100	Bureau of Economic Analysis
Unemployment rate	Annual unemployment rate, calculated as average monthly unemployment rate.	5.56	1.88	2.30	13.78	1100	Bureau of Labor Statistics
Foreign population share	Share of foreign-born population. Data for 1991–1999 and 2001–2004 interpolated using CAGR between two closest years.	7.64	5.77	1.07	27.42	1100	Gibson and Lennon (1999); U.S. Census Bureau, 2000 Decennial Census, American Community Survey 2005–2015
Population density	100 s of persons per square mile of land.	1.88	2.53	0.01	12.15	1100	Population: U.S. Census Bureau, State Population Tables 2010–2016, State Intercensal Tables 2000–2010, as reported by STATSINDIANA 1992–1999. Land area: U.S. Census Bureau American Fact Finder 2000, 2010, as reported by Iowa Data Center 1990.
Human capital	Share of adult population (25 + years of age) with a bachelor's degree or higher	26.11	5.10	12.60	41.50	1100	U.S. Census Bureau, Current Population Survey (1991–2006); American Community Survey (2006–2015). Average of two 2 series used for 2005–2006.
Academic R&D	Higher education R&D expenditures per capita	409.85	582.81	9.41	2824.99	1100	National Science Foundation, Survey of R&D at Universities & Colleges, 1992–2009; Higher Education R&D Survey, 2010–2015.

Notes: All variables are annual state-level measures. The sample period is 1993–2015.

Table 2
Correlation matrix.

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)	Entry rate	1																	
(2)	Birth job creation	0.88*	1																
(3)	Exit rate	0.69*	0.70*	1															
(4)	Death job destruction	0.69*	0.78*	0.81*	1														
(5)	Private infrastructure investment	0.36*	0.30*	0.13*	0.11*	1													
(6)	Public infrastructure investment	0.04	−0.02	0.07*	−0.05*	0.21*	1												
(7)	Corruption	−0.12*	−0.05*	−0.09*	−0.03	−0.10*	0.08*	1											
(8)	Citizen Ideology	−0.30*	−0.32*	−0.16*	−0.23*	−0.15*	−0.06*	−0.04	1										
(9)	Tax distortion index	−0.04	−0.04	−0.03	−0.01	−0.11*	−0.23*	−0.15*	0.35*	1									
(10)	Labor market frictions index	0.04	0.07*	0.12*	0.15*	−0.19*	0.10*	0.03	0.03	0.32*	1								
(11)	Government consumption index	0.22*	0.25*	0.09*	0.17*	0.24*	−0.38*	−0.08*	−0.24*	−0.26*	−0.50*	1							
(12)	Economic Growth	0.24*	0.23*	−0.08*	0.10*	0.10*	−0.16*	−0.03	−0.09*	0.02	0.06*	0.16*	1						
(13)	GDP less infrastructure	−0.16*	−0.20*	−0.12*	−0.20*	0.10*	0.55*	−0.01	0.32*	−0.14*	−0.37*	−0.14*	−0.10*	1					
(14)	Unemployment rate	−0.24*	−0.29*	0.09*	−0.13*	−0.29*	0.11*	0.03	0.18*	0.02	0.26*	−0.51*	−0.33*	−0.02	1				
(15)	Population density	−0.14*	−0.14*	−0.02	−0.04	−0.15*	−0.16*	0.02	0.51*	0.18*	−0.20*	−0.02	−0.03	0.40*	0.12*	1			
(16)	Foreign population share	0.17*	0.10*	0.27*	0.13*	0.09*	0.21*	−0.09*	0.37*	0.19*	−0.2*	−0.06*	−0.12*	0.51*	0.22*	0.48*	1		
(17)	Human capital	−0.19*	−0.25*	−0.12*	−0.20*	−0.05*	0.19*	−0.11*	0.42*	0.00	−0.47*	−0.02	−0.12*	0.70*	−0.02	0.45*	0.52*	1	
(18)	Academic R&D	0.01	−0.04	0.08*	0.02	−0.08*	0.10*	−0.05	0.11*	−0.09*	−0.1*	0.00	−0.06*	0.23*	0.2*	0.21*	0.38*	0.18*	1

Pairwise correlations for N = 1100 sample.

* Indicates correlation that is statistically significant at $p < 0.05$ or better.

3.3. Infrastructure investment

I examine the effects of both public and private infrastructure investments on dynamism. I measure both variables as real state-level real infrastructure investment per capita and lag both measures one year relative to the DV to minimize potential reverse causality, as dynamism in period *t* cannot influence infrastructure investments in period *t-1*.

I obtained the *Public infrastructure investment* data from the annual U.S. Census Bureau State and Local Government Finance Survey public use data files for the period 1992–2015. The annual data files contain detailed nominal public expenditure data and represent the value of newly developed public infrastructure. Items coded with prefixes F (construction expenditures) and G (purchases of land and existing structures) represent public infrastructure investments and I used them to construct variables for each item code representing a different type of infrastructure. There are 37 distinct types of infrastructure types for which data are available across all periods analyzed –see Table 5. I summed over these items to develop total public infrastructure investment.[8] I then adjusted the figures to constant 2015 dollars using the CPI-U from the BLS and normalized by the population to account for the impact of public infrastructure investment on the average person in a state.[9,10]

I use private non-residential construction data from the U.S. Census Bureau as a proxy for state-level *Private infrastructure investment*. The construction data are estimated from monthly samples of property owners who are asked to report the value of all work completed on their projects each month. The cumulative value of all work done on construction projects active during the year represents the annual value.[11] As with public infrastructure investment, I adjust the private infrastructure investment to constant 2015 dollars using the CPI-U and normalize by the population.

3.4. Institutional and policy context

Economists define institutions as "the humanly devised constraints that structure political, economic and social interactions," consisting of informal constraints and formal rules that serve as the rules of the game governing economic behavior (North, 1991, pp. 97–98). Because of the role of institutions and policies in shaping the incentives faced by entrepreneurs (Baumol, 1990; Zahra and Wright, 2011), they are the "antecedents of the incidence and nature… of entrepreneurship (Bjornskov and Foss, 2016, p. 294)." Previous research has identified the institutions and policies consistent with the principles of economic freedom to be robust determinants of entrepreneurial activity across countries (Dau and Cuervo-Cazurra, 2014; Nikolaev et al., 2018).

Following several empirical studies on state-level economic freedom and entrepreneurial activity (Gohmann et al., 2008; Sobel, 2008; Xue and Klein, 2010), I employ several measures from the *Economic Freedom of North America* (EFNA) index (Stansel et al., 2017). The EFNA index is comprised of three sub-indices: (1) *Government consumption index*, (2) *Tax distortion index*, and (3) *Labor market frictions index*.[12] I use the three sub-indices as control variables rather than the composite EFNA index because prior research suggests that they may exert differential impacts on dynamism (Barnatchez and Lester, 2017; Campbell et al., 2012; Cumming and Li, 2013).

[8] The Census Bureau provides annual aggregated state-level infrastructure spending data on its website, but these variables do not include the infrastructure spending for liquor stores, water utilities, electric utilities, gas utilities, or transit utilities. In addition, the aggregated measures include infrastructure spending for forestry, data for which is not available in the micro data. The pre-aggregated data include some aggregate infrastructure subcomponents, but these data are not as comprehensive as can be derived from the micro data and are not constructed using the same components. For instance, some of the pre-aggregated subcomponents also include items with the prefix K (equipment purchases), while others do not. Using the micro data, it is possible to derive harmonious subcomponents. Comparable data files for the years 2001 and 2003 were not publicly available, so infrastructure variables for these years were estimated as the average of the two closest years for each missing year, after adjusting for inflation.

[9] Population data are from the U.S. Census Bureau but were collected from three sources: (i) U.S. Census Bureau, State Population Tables: 2010–2016. Retrieved on 11/2/17 from https://www.census.gov/programs-surveys/popest/data/tables.html; (ii) U.S. Census Bureau, State Intercensal Tables: 2000–2010. Retrieved on 11/2/17 from https://www.census.gov/programs-surveys/popest/data/tables.2007.html; and (iii) U.S. Census Bureau, as reported by STATSINDIANA. Retrieved on 11/2/17 from http://www.stats.indiana.edu/population/PopTotals/intercensal90s_states.asp.

[10] On average, public infrastructure investment is highest among the less densely populated states in the West region ($1440 average annual real per capita investment per state), driven primarily by Alaska and Wyoming. Excluding these two sparsely population states, states in the West region still exhibit significantly higher annual investment ($1234) than the average state in the Midwest ($1090), Northeast ($910), and South ($960) regions. Within the Midwest region, Nebraska and North Dakota spend the most on public infrastructure, while Michigan and Missouri spend the least. Within the Northeast region, New York and Massachusetts spend the most on public infrastructure, while Maine and New Hampshire spend the least. Within the South region, Delaware, Texas, and Georgia spend the most on public infrastructure, while Arkansas and West Virginia spend the least.

[11] The sample includes construction projects related to lodging, office space, commercial facilities, health care, education, religious organizations, amusement and recreation, transportation, and manufacturing sectors, as well as private public safety, non-railroad transportation, highway and street, sewage and waste disposal, water supply, and conservation and development projects. The sample excludes, however, the value of power, communication, and railroad construction projects.

[12] Each sub-index is derived from several underlying component variables. Each component is transformed to a 0–10 scale that is decreasing in government restrictions and is assigned an equal weight for the sub-index to which it belongs, and each area is given an equal weighting in the composite index score. In order to improve the interpretation of results, the scales of the tax freedom and labor market freedom indices are reversed such that higher values reflect greater distortions.

Corruption is another institutional indicator that has been linked to entrepreneurial activity, but there is mixed evidence as to whether corruption acts as a constraining or an enabling institution for entrepreneurship (Bologna, 2017; Dreher and Gassebner, 2013; Dutta and Sobel, 2016). Following a growing body of literature examining the causes and consequences of corruption in the U.S. (e.g., Boudreaux et al., 2017; Johnson et al., 2014), I control for state-level *Corruption* using Federal official corruption conviction data from the Department of Justice's (DOJ) annual Reports to Congress on the Activities and Operations of the Public Integrity Section (PIN).[13] I normalize the corruption data by the state population and lag it by two years relative to the DV to approximate the period in which corruption took place.[14]

The sociological perspective on institutions suggests that, in addition to serving as constraints to entrepreneurs, institutions are social systems that act to "transmit values and influence cognition… [in ways] that may influence…entrepreneurial action (Bjornskov and Foss, 2016, p. 296)." This social-systems perspective emphasizes the embeddedness of individuals within a relational system (Kim et al., 2016) of "widely shared beliefs, values, and ideological tenets that can act to inspire or inhibit entrepreneurial endeavors (Chung and Gibbons, 1997, p. 17)." Denzau and North (1994, p. 4) depict both institutions and ideologies as shared mental models that "groups of individuals possess that provide both an interpretation of the environment and a prescription as to how the environment should be structured." To account for the potential impact of ideology on dynamism, I include state *Citizen ideology* (Berry et al., 1998) as an additional institutional control variable. Citizen ideology provides a 0–100 measure of the average location of the active electorate in each state on a liberal-conservative continuum, with higher scores reflecting a more liberal ideology (Berry et al., 2010, p. 119).

3.5. Market size

States with greater economic output and spatial density provide a higher intensity of economic activity and facilitate the flow of ideas and knowledge, providing more entrepreneurial opportunities (Audretsch and Keilbach, 2008). I therefore include two measures of market size in the analysis: (i) economic output, measured by the log of real GDP per capita, excluding both public and private infrastructure investments (*GDP less infrastructure*); and (ii) the *Population density*, or population per square mile of land. I obtained the state-level GDP data from the Bureau of Economic Analysis (BEA)[15] and the population data from the U.S. Census Bureau.[16]

3.6. Economic performance

I include two measures of economic performance as control variables. First is *Economic growth*, or the growth rate of real annual per capita GDP. A robust and growing regional economy implies increasing wealth and a growing market size, providing a greater intensity of economic exchange (Audretsch and Keilbach, 2008). It also reflects growing demand for products and services (Reynolds et al., 1994). A growing economy may also instill greater confidence in entrepreneurs, firms and investors, leading to greater investment and business and job creation. Second is the annual state *Unemployment rate*. I construct this variable from monthly state-level unemployment rate data from BLS, with the annual unemployment rate representing the average monthly rate for the year. Conventional wisdom is that there is a positive link between high unemployment and self-employment because discouraged unemployed workers are likely to perceive self-employment as their best option; however, empirical evidence on the relationship between unemployment and entrepreneurial activity is mixed (Fritsch, 2013; Storey, 1991; Thurik et al., 2008).

[13] The corruption conviction data contained in these reports is based on a DOJ survey of U.S. district attorneys about their activities in corruptions cases during the previous calendar year (Boylan and Long, 2003). The reports provide data by Federal district, which allows tabulation of annual state-level corruption convictions.

[14] The variable reflects the number of corruption convictions per 1 million persons. Cordis and Milyo (2016) estimate that the delay from referral to conviction is 1.4 to 1.7 years. They also provide several criticisms of the PIN data and argue that researchers should instead use the TRACS dataset. The limitations of the PIN data were considered but it was determined that the current research would not be hampered by them. First, corruption convictions in the PIN data involve cases of both elected and unelected government officials, including low-level public employees, with most cases involving federal, not state officials. These distinctions are not relevant for the current study as corruption at any level may distort the allocation of entrepreneurial resources (Boudreaux et al., 2017) and infrastructure allocations may be influenced by public officials at all levels of government (Liu and Mikesell, 2014). Second, they note that the PIN data are derived from survey and not administrative records. While this limitation is noted, Liu and Mikesell (2014) show that the PIN corruption convictions data are highly correlated with state corruption perceptions rankings. Next, they note that there are inconsistencies across annual reports in the PIN data for overlapping years prior to 1991. The analysis period for the current study is 1992–2015, so this is not an issue. They also note that significant share of federal corruption conviction cases involve postal employees. This is not a major issue for the current study unless there is significant heterogeneity across states in postal convictions.

[15] The BEA data were based on the SIC industrial classification codes until 1997 and the NAICS codes thereafter. The change in the classification systems creates a discontinuity in the GDP series. Both classifications series provide GDP figures for 1997. I use the average of the two for this year.

[16] I normalized population by state land area, which I collected from the U.S. Census Bureau, American Fact Finder, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF1_GCTPH1.US01PR&prodType=table, for the years 2000 and 2010, and for 1990 from the U.S. Census Bureau, American Fact Finder, as reported by Iowa Data Center, http://www.iowadatacenter.org/datatables/UnitedStates/usstlandarea19902000.pdf. There are minor differences in land area by year, so I use the 1990 data as the denominator of the population density calculation for years 1992–1995, but the 2000 and 2010 land area data in the calculations for years spanning 1996–2005 and 2006–2015, respectively.

3.7. Knowledge

Knowledge is largely created and disseminated through investments in R&D and human capital (Audretsch, 2007). The knowledge spillover theory of entrepreneurship suggests that regions rich in knowledge will generate more entrepreneurial opportunities than ones relatively poor in knowledge (Acs et al., 2013; Audretsch and Keilbach, 2007). Education, it is widely believed, provides cognitive skills and knowledge (Shane, 2003) that enable individuals to master complex technical problems and develop innovations in the form of strategic entrepreneurial ventures (Lofstrom et al., 2014). Education also serves as a source of entrepreneurial absorptive capacity (Qian et al., 2013). R&D investments generate tacit knowledge that often spills over to local firms and entrepreneurs who exploit it to develop innovations (Audretsch and Feldman, 1996; Audretsch and Lehmann, 2005). I therefore controls for two state-level measures of knowledge. First is the level of human capital. Following numerous studies (e.g., Lee et al., 2004; Qian et al., 2013), I measure *Human capital* by the adult college attainment, or the proportion of the 25+ population with a bachelor's degree or higher, using data from the U.S. Census Bureau.[17] Second is *Academic R&D* expenditures, which I obtained from the National Science Foundation (NSF),[18] adjusted to constant 2015 USD using the CPI-U and normalized by state population.[19]

3.8. Population diversity

The Melting Pot hypothesis suggests that immigrants are more likely to be self-employed than native-born residents because (i) they bring new ideas and cultures, creating new business opportunities; and (ii) they lack the skills, resources, and networks necessary to obtain high-paying jobs (Lee et al., 2004; Reynolds et al., 1995). I therefore control for the foreign-born population share (*Foreign*) as a proxy for population diversity.[20]

3.9. Methodology

I examine the relationship between infrastructure investment and dynamism across US states over the period 1993–2015 using the System GMM estimator (Arellano and Bover, 1995; Blundell and Bond, 1998), a method employed in several recent entrepreneurship studies (e.g., Croce et al., 2013; Tran, 2018). System GMM is an appropriate estimator for the current analysis for numerous reasons. First, it accounts for fixed state-level effects to control for unmeasurable, time-invariant idiosyncratic variation. Second, the process by which the various dependent variables (DVs) are generated is likely dynamic, meaning that current values are influenced by past ones such that dynamism may be persistent over time (Davis and Haltiwanger, 1992; Kirchhoff and Phillips, 1988). System GMM is a dynamic panel model that controls for lagged values of the DV and is designed to avoid the Nickell (1981) autocorrelation bias that arises by including these lags and state fixed effects in the same equation Third, infrastructure investments may be endogenous if policymakers increase public investments in response to a slowdown in dynamism.[21] Due to the panel structure of my dataset, a time-varying exogenous instrumental variable that only impacts dynamism though infrastructure investment is unavailable. System GMM uses lagged differences of the endogenous variables as instruments to overcome potential endogeneity. Lastly, my dataset includes 1100 state-year observations spanning the period 1993–2015 and System GMM is appropriate for panels with "small T, large N."

$$Dyn_{i,t} = \alpha_0 + \alpha_1 Dyn_{i,t-1} + \alpha_2 Dyn_{i,t-2} + \beta_1 PubInf_{i,t-1} + \beta_2 PrivInf_{i,t-1} + X_{i,t}'\gamma + \theta_i + \nu T_t + \epsilon_{i,t} \tag{1}$$

I use the Stata command ***xtabond2*** (Roodman, 2009a) to derive System GMM estimates of Eq. (1), where: $Dyn_{i,\ t}$ is one of the four dynamism indicators in state i and year t; $PubInf_{i,\ t-1}$ and $PrivInf_{i,\ t-1}$ denote one period lagged values of public and private infrastructure investment, respectively; $X_{i,\ t}$ is a matrix of control variables, θ_i and T_t are vectors of state and year fixed-effects, respectively[22]; and $\epsilon_{i,\ t}$ is an idiosyncratic error terms. β_1 and β_2 are parameters that capture the short-run impact of public infrastructure

[17] To generate a time series spanning the period of analysis, I compile state-level data from three sources: (i) the U.S. Census Bureau CPS, 1995–2004; (ii) the U.S. Census Bureau American Community Survey (ACS), 2006–2015; and (iii) the 1990 U.S. Census Bureau Decennial Census of the Population. Data for the period 1992–1994 were interpolated using the compound annual growth rate (CAGR) between the 1990 Decennial Census and 1995 CPS college attainment rates. I use an average of the college attainment rates for the overlapping years, 2005 and 2006, between the CPS and ACS dataset to smooth out differences between the two series.

[18] The NSF administered the Survey of R&D at Universities and Colleges over the period 1972–2009, but replaced it beginning in 2010 with the Higher Education R&D Survey. Beginning in 1998, the state-level data pertain to college and university R&D, whereas earlier data pertain only to doctoral granting universities. Data for both samples are available over the period 1998–2002, so I calculated the ratio of the former to the latter for each state-year to develop an adjustment factor to apply to the pre-1998 data. The average ratio across states for each year is 1.02. The state-year ratios were relatively constant across the five overlapping years for most states, but there were a few states exhibiting noticeable variance. The state-year ratio variance for such states was much lower over the 1998–1999 period, so I used the average ratio over these two years as the adjustment factor for pre-1997 data.

[19] Because the data reflect fiscal year R&D expenditures, I apply half of the expenditures for year t to year t and half to year t + 1 (e.g., FY2015 assigned 50/50 to 2015/2016) to better reflect when the expenditures occurred and to more accurately adjust for inflation.

[20] These data are derived from three sources: (i) the U.S. Census Bureau American Community Survey 1-year estimates, 2005–2015; (ii) the 2000 U.S. Census Bureau Decennial Census, summary file 4; and (iii) Gibson and Lennon (1999). Data for the years 1992–1999 and 2001–2004 were interpolated using the CAGR between the 1990 and 2000 and 2000 and 2005 observations, respectively.

[21] I also lag infrastructure investment relative to dynamism to minimize this possibility.

[22] The inclusion of year fixed effects eliminates the possibility of contemporaneous correlation across states (Roodman, 2009a).

investment and private infrastructure investments in year *t-1* on dynamism in year *t*, respectively. Because the dynamic model includes lagged dependent variables, which capture the persistence of dynamism, the effects of infrastructure investment compound over time, resulting in a long-run multiplier effect (Enders, 2014). The long-run dynamic effects of public and private infrastructure investments are given by $\frac{\beta_1}{1-\alpha_1-\alpha_2}$ and $\frac{\beta_2}{1-\alpha_1-\alpha_2}$, respectively.[23]

4. Empirical results

4.1. Main results

I present the main System GMM results in Table 3. The DV for each model is indicated in the column heading. System GMM is a dynamic model in that it controls for lagged values of the DV. The lagged DVs, along with public and private infrastructure investment, are treated as endogenous and instrumented for with their lagged first differences. To eliminate the problem of instrument proliferation, which can invalidate results, I collapse the instrument matrix and impose instrumental variable lag limits that satisfy the following conditions: (1) the null of the Hansen J test of over-identifying restrictions is not rejected and is not implausibly perfect (i.e., $0.05 \le p(Hansen) < 1.00$); and (2) there is no second-order autocorrelation in the model (i.e., $p(AR2) > 0.05$) (Roodman, 2009b). I include two lags of the DV in the models for the two creation constructs and Death job destruction, but only one lag in the models for Exit rate.[24] I include the variables described in Section 3 as pre-determined controls in all models, as well as fixed state and year effects. I present the main results in the odd-numbered models and these are the focus of the analysis in this section.

Consistent with Hypotheses 1A and 2A, private infrastructure investment is positively and significantly associated with both creation dynamism variables – Entry rate and Birth job creation. Contrary to Hypotheses 1A and 2A, however, public infrastructure investment is not significantly associated with either creation dynamism variable. The opposite is true for the destruction dynamism variables. That is, consistent with Hypotheses 1B and 2B, public infrastructure investment is positively and significantly associated with both Exit rate and Death job destruction. Contrary to Hypotheses 1B and 2B, private infrastructure investment is not significantly associated with either destruction dynamism variable.

These results suggest that the source of infrastructure investments matters for dynamism, with private investments acting to enable the creation of businesses and jobs and public investments serving a disabling role that induces business exits and job losses. In other words, private infrastructure investment is beneficial for business and job creation, while public infrastructure investment may eliminate businesses and jobs.[25] After controlling for lagged values of the DVs, a host of control variables, and fixed state and year effects; however, the magnitude of the short-run effects of infrastructure investment on dynamism are rather small. A $1000 increase in private infrastructure investment per capita is associated with percentage point increases in the entry and birth job creation rates of 0.11 and 0.13 percentage points the following year, respectively. Statistically, a standard deviation increase in private infrastructure investment per capita is associated with standard deviation increases in Entry rate and Birth job creation of 0.03 and 0.05, respectively. The long-run dynamic effects of private infrastructure investments, denoted as Long Run-Private, suggest that a $1000 increase in private infrastructure investment per capita will increase the entry and birth job creation rates by 0.6 and 0.2 percentage points, respectively, over time.

Meanwhile, a $1000 increase in public infrastructure investment per capita is associated with increases in the exit and death job destruction rates of 0.42 and 0.23 percentage points, respectively. Statistically, a standard deviation increase in public infrastructure investment per capita is associated with standard deviation increases in Exit rate and Death job destruction of 0.18 and 0.19, respectively. The long-run dynamic effects of public infrastructure investments, denoted as Long Run-Private, suggest that a $1000 increase in public infrastructure investment per capita will increase the exit and death job destruction rates by 1.1 and 0.3 percentage points, respectively, over time.[26]

[23] Several assumptions are necessary to derive the long-run multiplier: (i) $0 < \alpha_1 < 1$; (ii) $0 < \alpha_2 < 1$; (iii) $\alpha_1 + \alpha_2 < 1$; and (iv) Dyn_t converges to a steady-state equilibrium $\overline{Dyn}$ (Enders, 2014). The specification employed when Exit rate is the dynamism indicator only includes one lag of the DV. For this specification, the denominator of the long-run effects of infrastructure investments are $(1 - \alpha_1)$.

[24] As indicated in Table 3, both the first and second lags of the DV for Entry rate, Birth job creation, and Death job destruction are positive and statistically significant. The second lag of Exit rate was not statistically significant at the 10% level in an analogous model, so only the first lag is included. The insignificance of the second lag suggests that the Exit rate is only persistent for one period, whereas the other DVs are persistent for two periods.

[25] Reynolds et al. (1994) and Reynolds et al. (1995) found no relationship between public infrastructure investments and entry rates. My findings are consistent with these two studies; however, my finding of a positive relationship between public infrastructure investment and Exit rate contradicts Reynolds et al. (1995). My results, however, are not directly comparable to these studies for numerous reasons. First, my analysis uses panel data while the previous studies are cross-sectional in nature. Additionally, I utilize the 50 U.S. states as the unit of analysis whereas Reynolds et al. (1995) focused on a narrower geographic region and Reynolds et al. (1994) on subnational regions in Europe. My study also uses different data sources and control variables. Furthermore, infrastructure investment is the focus of my analysis while the two previous studies were more exploratory in terms of identifying potential regional determinants of firm entry and exit rates.

[26] There is substantial disagreement among economists regarding the relationship between public and private investment. Some have argued that the two are complementary such that public investment encourages additional private investment (i.e., the crowd-in hypothesis), while others believe that they are substitutes such that public investment crowds out private investment. The empirical evidence is mixed, however (c.f., Argimon et al., 1997; Aschauer, 1989a; Voss, 2002). Although it is beyond the scope of the current analysis to examine the relationship between public and private infrastructure investment, I do examine the net effect of these two sources of infrastructure investment on dynamism by re-running the main results using combined public and private infrastructure investment in lieu of the two measures independently. These results are presented in Appendix Table A1. Total infrastructure investment is positively and significantly associated with both measures of Creation dynamism and Exit rate. It is positively but not significantly associated with Death job destroy.

Table 3
Dynamic panel system GMM results.

	DV = Creation				DV = Destruction			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Entry rate	Entry rate	Birth job creation	Birth job creation	Exit rate	Exit rate	Death job destruction	Death job destruction
DV, lagged 1 year	0.620***	0.620***	0.205***	0.196***	0.626***	0.722***	0.145***	0.146***
	[0.045]	[0.047]	[0.043]	[0.041]	[0.062]	[0.070]	[0.036]	[0.045]
DV, lagged 2 years	0.193***	0.197***	0.198***	0.189***			0.078**	0.081**
	[0.036]	[0.034]	[0.036]	[0.038]			[0.031]	[0.033]
Private infrastructure investment	0.011*	0.012**	0.013*	0.009*	−0.001	−0.009	0.002	−0.001
	[0.006]	[0.005]	[0.007]	[0.005]	[0.006]	[0.007]	[0.004]	[0.005]
Public infrastructure investment	0.010		0.001		0.042**		0.023**	
	[0.016]		[0.014]		[0.019]		[0.011]	
Public infrastructure - factor 1		0.013		0.021		0.044**		0.040**
		[0.022]		[0.022]		[0.019]		[0.020]
Public infrastructure - factor 2		0.042		−0.001		0.109		0.036
		[0.039]		[0.037]		[0.069]		[0.040]
Public infrastructure - factor 3		0.020		0.027		0.103*		0.064
		[0.025]		[0.051]		[0.059]		[0.052]
Public infrastructure - factor 4		−0.245**		−0.168		−0.127		−0.137
		[0.106]		[0.169]		[0.179]		[0.117]
Public infrastructure - factor 5		0.005		−0.078		−0.173*		−0.125
		[0.074]		[0.067]		[0.097]		[0.091]
Corruption	−0.003	−0.004	−0.003	−0.005	0.002	−0.001	0.005	0.002
	[0.005]	[0.004]	[0.008]	[0.008]	[0.006]	[0.007]	[0.008]	[0.008]
Tax distortion index	−0.018	0.007	−0.084	−0.069	0.001	0.055	−0.070	−0.047
	[0.031]	[0.036]	[0.062]	[0.064]	[0.039]	[0.041]	[0.059]	[0.068]
Labor market friction index	−0.148***	−0.164***	−0.152**	−0.171**	−0.106	−0.121*	−0.125	−0.137*
	[0.057]	[0.049]	[0.068]	[0.069]	[0.066]	[0.068]	[0.078]	[0.078]
Government consumption index	−0.027	−0.012	−0.029	−0.007	0.060*	0.102***	−0.005	0.022
	[0.031]	[0.037]	[0.036]	[0.035]	[0.034]	[0.036]	[0.036]	[0.039]
Citizen ideology	−0.003	−0.004*	−0.010***	−0.011***	−0.005*	−0.007**	−0.007**	−0.009***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.003]	[0.003]	[0.003]	[0.003]
Economic growth	0.024***	0.026***	−0.000	0.002	−0.007	−0.003	0.003	0.005
	[0.008]	[0.008]	[0.012]	[0.012]	[0.010]	[0.011]	[0.009]	[0.009]
GDP less infrastructure	−0.256	−0.295	−0.203	−0.306	−0.660*	−0.583	−0.719	−0.816*
	[0.378]	[0.400]	[0.501]	[0.512]	[0.399]	[0.401]	[0.459]	[0.489]
Unemployment rate	0.020	0.026	0.039	0.051*	0.115***	0.093***	0.061**	0.068**
	[0.017]	[0.016]	[0.027]	[0.028]	[0.028]	[0.030]	[0.028]	[0.028]
Population density	−0.029*	−0.028	−0.052***	−0.053***	−0.011	−0.017	−0.021	−0.024
	[0.015]	[0.019]	[0.018]	[0.016]	[0.017]	[0.020]	[0.017]	[0.017]
Foreign population share	0.030***	0.028**	0.054***	0.054***	0.032***	0.020*	0.048***	0.045***
	[0.010]	[0.012]	[0.010]	[0.010]	[0.009]	[0.010]	[0.008]	[0.009]
Human capital	0.002	0.001	−0.004	−0.003	0.012	0.003	0.008	0.008
	[0.008]	[0.009]	[0.014]	[0.014]	[0.009]	[0.007]	[0.013]	[0.013]
Academic R&D	0.000	0.000	−0.000	−0.000	−0.000	0.000	−0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
N	1100	1100	1100	1100	1100	1100	1100	1100
Groups	50	50	50	50	50	50	50	50
Long run - private	0.06	0.07	0.02	0.01	0.00	−0.03	0.00	0.00
Long run - public	0.05		0.00		0.11		0.03	
p(Public)		0.08		0.67		0.08		0.10
p(Hansen)	0.84	0.93	0.95	0.92	0.66	0.568	0.53	0.76
p(AR1)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p(AR2)	0.37	0.36	0.38	0.44	0.09	0.07	0.78	0.75
p(AR3)	0.30	0.23	0.26	0.30	0.31	0.30	0.49	0.43
Lag limit A	1	1	1	1	2	2	1	1
Lag limit B	6	2	6	3	7	3	3	2
# of instruments	57	57	57	64	56	56	48	57

Dynamic panel system GMM estimates using Stata command xtabond2 (Roodman, 2009a). Italicized variables treated as endogenous and instrumented with their lagged first-differences. The coefficients for the infrastructure investment variables represent their short-run effects, while the long-run multiplier effect of the two infrastructure investment variables on the respective DV in the odd-numbered models are denoted as Long Run Effect - Private and Long Run Effect - Public. p(ARi) is the *p*-value from the Arellano-Bond tests for AR(i) in first differences. By construction, the dynamic panel estimator exhibits first-order serial correlation of residuals in differences, but second-order autocorrelation renders the instruments invalid. p(Hansen) is the *p*-value of the robust Hansen test of over identifying restrictions. To reduce the bias and potential for false positive results caused by instrument proliferation, the instrument matrix is collapsed and lag limits are introduced that satisfy autocorrelation and over-identification conditions for valid instruments (Roodman, 2009a, 2009b). Models 5 and 6 exclude the 2nd lag of the DV as it is statistically insignificant; however, to avoid second-order autocorrelation, the differenced instrumental variables are lagged 2 periods relative to the endogenous variables. Even-numbered models decompose public infrastructure investment into 5 separate factors according to Principle Component Factor Analysis - see Table 4 for details. p(Public) is the *p*-value from a joint test of significance of the 5 factors. All models include time dummies and a constant - results omitted for space. Robust standard errors in brackets. All *p*-values are based on two-tailed tests.

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Next, I discuss the results pertaining to the institutional and policy variables. The labor market friction index is negatively associated with all four dynamism measures, but it is only significant in the creation models. The government consumption index is positively and significantly associated with Exit rate. Citizen ideology is negatively associated with all four dynamism measures and it is significant in all but the Entry rate model. My results suggest that: (i) more labor market frictions are associated with less creation dynamism[27]; (ii) greater government consumption is associated with more establishment exits[28]; and (iii) more liberal citizen ideology is associated with less destruction dynamism and less Birth job creation. Corruption and the Tax distortion index are not statistically significant in any of the models.

Next, I describe the results for the remaining control variables. Economic growth is positively and significantly associated with Entry rate. Unemployment rate is positively and significantly associated with both measures of destruction. Population density is negatively and significantly associated with both measures of creation. GDP less infrastructure is negatively and significantly associated with Exit rate. Foreign population share is positively and significantly associated with all four dynamism measures, providing support for the Melting Pot hypothesis (Lee et al., 2004). Neither of the knowledge variables, Human capital or Academic R&D, are significantly associated with any of the dynamism measures.[29,30]

4.2. Heterogeneity of public infrastructure investment

Public infrastructure investment is an aggregate measure comprised of investment in 37 different types of infrastructure. Infrastructure is heterogeneous in function and form, as well as potentially its impact on entrepreneurial activity (Audretsch et al., 2012; Audretsch et al., 2015) and economic outcomes (Aschauer, 1989b; Pereira and Andraz, 2013). As such, the impact of public infrastructure investment on dynamism may be heterogeneous across different types of infrastructure. Because of the large number of underlying public infrastructure investment components, I employ two methods to decompose total infrastructure investments into a small number of variables to examine the potential heterogeneous impact of public infrastructure investment on dynamism.

First is a *pseudo principle component factor analysis* (pseudo PCFA) that involved three steps. First, I completed a PCFA using the *factor* command in Stata. For this step, I required a minimum eigenvalue of one for each factor and restricted the number of factors to five. I then performed an oblique rotation of the loading matrix (Clarkson and Jennrich, 1988). Second, I assigned each variable to the factor for which it has the highest load value. Third, I summed over the variables assigned to each of the factors to derive five distinct public infrastructure investment factors for each state-year. This method preserves the scale of the total public infrastructure investment measure, allowing for meaningful comparisons of the results. It also ensures that the factors are derived in a summative manner, not allowing negative loadings to reduce the value of a factor. Additionally, it maps each infrastructure spending variable to only one factor for ease of interpretation.[31] Table 4 provides the results of the PCFA in panel A, with summary statistics for each resulting factor given in panel B.

I present the results using the five factors in lieu of total public infrastructure investment in the even-numbered models in Table 3. Recall that total public infrastructure investment has a positive but insignificant relationship with both creation dynamism measures in models 1 and 3. In model 2, only factor 4 enters significantly and is negatively associated with Entry rate, while none of the factors are significantly associated with Birth job creation in model 4. Recall also that total public infrastructure investment has a positive and significant relationship with both destruction dynamism measures in models 5 and 7. The former result (i.e., Exit rate), is driven by factors 1 and 3, although factor 5, which is comprised primarily of hospital and water and electric utility infrastructure, has a

[27] My finding that fewer labor market frictions are associated with more establishment births is consistent with Cumming and Li (2013).

[28] Campbell et al. (2012) found a negative relationship between firm exits and both government consumption and labor market frictions. My results are consistent with the former but not the latter as I found no relationship between labor market frictions and exits. My results are not directly comparable because Campbell et al. (2012) use an alternative measure of exits, take the natural log of the policy variables, and use a fixed effects model.

[29] The null relationship between the two knowledge variables and Entry rate is inconsistent with the regional knowledge spillover theory of entrepreneurship (Audretsch and Lehmann, 2005).

[30] Several findings with respect to the fixed year effects are worth mentioning. First, the economy generally exhibited greater dynamism during periods of higher-than-average economic growth (e.g., mid 1990s, 2005–06), as the period variables are positively and significantly association with both the creation and dynamism measures during these years. Second, the economy exhibited less creation and more destruction during the years spanning the Great Recession. Interestingly, establishment destruction has declined in the years since the Great Recession ended, as the period effects are negatively and significantly associated with Exit rate beginning in 2010.

[31] Traditional factor analysis methods use the factors loadings to apportion the values of each variable to the factors, with some of the variables adding to and others subtracting from the resulting factors in such a way that results in orthogonal factors. My goal is not necessarily to achieve a low-dimensional structure consisting of orthogonal factors, but rather to employ a more data-driven approach to group the 37 infrastructure investment variables into a smaller number of aggregate variables in a manner that preserves the integrity of the data and the unit of measurement.

Table 4
Psuedo PCFA factor assignment method.

Panel A: PCA results

Infrastructure type	Factor1	Factor2	Factor3	Factor4	Factor5	Unique
Air transportation	**0.31**	0.29	0.03	−0.02	−0.20	0.67
Misc commercial activities	0.13	**0.86**	−0.20	−0.10	0.11	0.25
Correctional institutions	0.23	−0.12	−0.03	**0.68**	0.17	0.47
Corrections other	−0.03	0.01	−0.17	**0.72**	0.16	0.53
Elementary & secondary education	**0.70**	0.13	0.05	−0.02	0.11	0.42
Higher education	0.06	−0.14	**0.32**	−0.45	0.07	0.72
Other higher education	**0.56**	0.17	0.00	−0.34	0.30	0.47
State education	0.11	**0.29**	−0.28	−0.17	−0.31	0.70
Social insurance administration	−0.18	0.09	−0.04	**0.43**	−0.18	0.75
Financial administration	**0.23**	0.03	0.09	0.17	−0.14	0.84
Local fire protection	**0.61**	0.18	0.09	0.04	0.11	0.47
Judicial and legal services	−0.02	0.26	**0.29**	0.09	−0.19	0.73
Central staff services	**0.73**	−0.08	−0.15	0.14	0.10	0.50
General public buildings	**0.52**	−0.37	0.30	0.00	−0.17	0.58
Health - other	0.04	**0.51**	0.31	0.16	0.15	0.52
Hospitals	0.43	−0.05	0.05	0.14	**0.56**	0.51
Regular highways	**0.61**	0.31	−0.26	−0.06	−0.01	0.45
Toll highways	−0.20	0.23	**0.33**	−0.25	−0.22	0.76
Housing & community development	−0.07	**0.60**	0.26	0.10	−0.07	0.48
Libraries	0.29	0.03	**0.30**	0.08	0.18	0.73
Natural resource	**0.61**	−0.04	−0.01	0.06	−0.11	0.61
Parking facilities	0.04	−0.04	−0.06	**0.09**	0.08	0.98
Parks & recreation	**0.52**	0.06	0.15	0.09	−0.10	0.58
Police protection	**0.47**	0.29	−0.14	0.00	−0.24	0.52
Protective inspection and regulation	0.02	0.02	0.19	**0.31**	−0.05	0.82
Public welfare institutions	**0.13**	0.08	−0.12	−0.17	−0.08	0.93
Public welfare - other	0.15	0.02	0.00	**0.26**	−0.30	0.77
Sewerage	0.08	0.03	**0.70**	−0.14	0.10	0.49
Solid waste mgmt	0.14	0.25	**0.32**	0.05	−0.02	0.72
State veterans services	0.07	0.00	0.03	−0.14	**0.09**	0.97
Sea & inland port facilities	−0.08	**0.81**	0.19	0.04	0.30	0.33
General other	0.11	**0.55**	0.01	−0.16	−0.09	0.60
Liquor stores	−0.10	0.00	−0.13	**0.05**	−0.17	0.94
Water utilities	**0.71**	−0.08	−0.03	0.01	0.06	0.54
Electric utilities	0.08	0.45	−0.03	0.07	**0.57**	0.58
Gas utilities	−0.15	0.29	−0.17	0.15	**0.59**	0.64
Transit utilities	−0.14	0.01	**0.79**	−0.11	−0.11	0.42

Panel B: Summary statistics by factor

	Factor1	Factor2	Factor3	Factor4	Factor5	Total
Mean	8.15	1.21	1.31	0.24	0.56	11.09
SD	3.4	0.99	1.03	0.2	0.71	4.5
Min	2.65	0.17	0.1	0.01	0	4.18
Max	30.27	11.45	7.88	2.69	6.72	41.61
N	1100	1100	1100	1100	1100	1100

Panel A reports the results from oblique rotated principle component factor analysis. Analysis restricted to 5 factors and minimum eigenvalues of 1. To preserve the economic meaning of the infrastructure variables, which are measured in real dollars per capita, the factor analysis is used to group the underlying variables into a single factor according to the maximum factor loading, as indicated in bold. 100% of each variable is then loaded into that variable such that each factor represents the sum of the variables for which their maximum load is onto that factor. Panel B report summary statistics for each factor as well as for total public infrastructure investment for comparison.

negative and significant effect. Meanwhile, the negative effect of public infrastructure on the Job destruction rate is driven by factor 1. The positive and significant relationship between private infrastructure investment and the two creation dynamism measures is robust in models 2 and 4, and the insignificant relationship with the two destruction dynamism measures is maintained in models 6 and 8. The results for the controls variables are also largely unchanged.

Next, I employed an ad-hoc *grouping method* by assigning the 37 components to ten public infrastructure investment groups by

Table 5
Ad-Hoc public infrastructure investment group assignment method.

Group	Mean	SD	Min	Max	N
Administrative infrastructure	1.08	0.62	0.13	6.22	1100
Central staff services					
Financial administration					
General other					
General public buildings					
Commercial infrastructure	0.2	0.34	0	3.5	1100
Liquor stores					
Misc commercial activities					
Natural resource					
Community infrastructure	0.59	0.44	0.07	5.32	1100
Housing & community development					
Libraries					
Parks & recreation					
Education infrastructure	2.83	1.13	0.55	9.97	1100
Elementary & secondary education					
Higher education					
Other higher education					
State education					
Health infrastructure	0.3	0.29	0	3.11	1100
Health - Other					
Hospitals					
Sanitation infrastructure	0.63	0.42	0.01	5.82	1100
Sewerage					
Solid waste mgmt					
Legal & security infrastructure	0.41	0.23	0.07	2.98	1100
Correctional institutions					
Corrections other					
Judicial and legal services					
Local fire protection					
Police protection					
Protective inspection and regulation					
Transportation infrastructure	3.88	2.02	1.35	19.29	1100
Air transportation					
Parking facilities					
Regular highways					
Sea & inland port facilities					
Toll highways					
Utility infrastructure	1.12	0.97	0.02	7.61	1100
Electric utilities					
Gas utilities					
Transit utilities					
Water utilities					
Welfare infrastructure	0.05	0.05	0	0.61	1100
Public welfare - other					
Public welfare institutions					
Social insurance administration					
State veterans services					
Total Infrastructure	11.09	4.5	4.18	41.61	1100

The 37 public infrastructure investment components are assigned to 1 of the 10 functional groups: Administrative, Commercial, Community, Education, Health, Legal & Security, Sanitation, Transportation, Utility, and Welfare.

common functionality and summed over the underlying components in each group to derive a value for it. I describe the groupings of the components and provide summary statistics for each group in Table 5. I re-estimate the baseline model for each DV for each of the ten public infrastructure investment groups in lieu of the total infrastructure investment and present these results in Table 6. Because the results pertaining to the control variables and model statistics are largely unchanged across specifications, I only present the coefficient and robust standard errors for the private and public infrastructure investment variables. Each row represents a different model for the DV listed in the column header. The public infrastructure investment measure used for each model is indicated in the last column. For ease of comparison, I reproduce the baseline results from Table 3 in row 1.

The positive and significant relationship between private infrastructure investment and the two measures of creation dynamism is robust across all models, with the coefficient size relatively stable. Similarly, private infrastructure investment remains insignificant across the destruction dynamism models. Total public infrastructure investment is insignificant in the creation dynamism models; however, there is some heterogeneity by infrastructure type. Commercial infrastructure investment is significant and positively associated with Entry rate, while Community infrastructure investment is significant and negatively associated with it. Additionally, health infrastructure is significant and negatively associated with Birth job creation. The remaining public infrastructure investment variables are insignificant in the creation dynamism measures.

Table 6
Dynamic panel system GMM results by infrastructure group.

	DV = Entry rate				DV = Birth job creation				
	Private		Public		Private		Public		
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Public infrastructure measure
(1)	0.011*	[0.006]	0.010	[0.016]	0.013*	[0.007]	0.001	[0.014]	Total
(2)	0.011*	[0.006]	0.006	[0.029]	0.014*	[0.007]	−0.001	[0.026]	Transportation
(3)	0.010*	[0.005]	0.204**	[0.084]	0.013*	[0.007]	0.146	[0.115]	Commercial
(4)	0.011**	[0.005]	−0.013	[0.024]	0.013**	[0.006]	0.002	[0.031]	Education
(5)	0.011**	[0.005]	0.347	[0.564]	0.014**	[0.007]	−0.146	[0.360]	Welfare
(6)	0.011**	[0.005]	0.019	[0.050]	0.014**	[0.007]	0.002	[0.060]	Administrative
(7)	0.011**	[0.005]	−0.169	[0.120]	0.014**	[0.006]	−0.102	[0.184]	Legal & security
(8)	0.011**	[0.005]	0.053	[0.077]	0.014**	[0.007]	−0.274**	[0.123]	Health
(9)	0.011**	[0.005]	−0.137***	[0.049]	0.012*	[0.007]	0.012	[0.072]	Community
(10)	0.011**	[0.005]	−0.006	[0.043]	0.014**	[0.007]	−0.062	[0.070]	Sanitation
(11)	0.011**	[0.005]	0.031	[0.039]	0.014**	[0.007]	−0.015	[0.041]	Utility

	DV = Exit rate				DV = Death job destruction				
	Private		Public		Private		Public		
	Coeff	SE	Coeff	SE	Coeff	SE	Coeff	SE	Public infrastructure measure
(1)	−0.001	[0.006]	0.042**	[0.019]	0.002	[0.004]	0.027**	[0.013]	Total
(2)	0.001	[0.005]	0.061*	[0.036]	0.003	[0.004]	0.033	[0.031]	Transportation
(3)	0.000	[0.005]	0.068	[0.102]	0.003	[0.004]	0.237***	[0.087]	Commercial
(4)	0.001	[0.005]	0.070**	[0.034]	0.005	[0.004]	0.068***	[0.023]	Education
(5)	0.001	[0.005]	−0.166	[0.464]	0.005	[0.005]	−0.279	[0.738]	Welfare
(6)	−0.003	[0.006]	0.285***	[0.091]	0.005	[0.004]	0.050	[0.042]	Administrative
(7)	0.001	[0.005]	0.032	[0.200]	0.005	[0.004]	0.052	[0.167]	Legal & security
(8)	0.004	[0.005]	−0.373**	[0.164]	0.007	[0.004]	−0.276***	[0.093]	Health
(9)	−0.001	[0.006]	0.092	[0.061]	0.005	[0.004]	−0.082	[0.089]	Community
(10)	0.002	[0.005]	−0.186	[0.172]	0.004	[0.004]	0.005	[0.053]	Sanitation
(11)	0.000	[0.005]	−0.014	[0.059]	0.005	[0.004]	0.029	[0.054]	Utility

Dynamic panel system GMM estimates using Stata command xtabond2 (Roodman, 2009a). Each row represents a different model for the respective DV indicated at the column head. The models reported in row (1) are reproduced from the baseline estimates in Table 3 using total public infrastructure spending as the measure of public infrastructure investment. Subsequent rows utilize the public infrastructure measure indicated in the last column - see Table 5 for additional details on these groupings. The model specifications in rows 2–11 are identical to the respective baseline models for each DV. Only the results for public and private infrastructure investment are reported as a means to further analyze how public infrastructure investment impacts dynamism. Results for the lagged DVs and control variables are stable for each set of models for the respective DV. Similarly, the results for the tests of autocorrelation and over-identification are stable across models for each DV. See Table 3 for additional details on the model specification. These results are omitted for space but available upon request. Robust standard errors in brackets. All p-values are based on two-tailed tests.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Total public infrastructure investment is positively and significantly associated with both destruction dynamism measures. The positive relationship with Entry rate is driven by Transportation, Education, and Administrative infrastructure investment, while the Death job destruction relationship is driven by Commercial and Education infrastructure investment. Health infrastructure investment, meanwhile, is negatively and significantly associated with both destruction dynamism measures, attenuating the overall positive effect of public infrastructure investment.

4.3. Alternative dynamism indicators

Although the EED model that I developed predicts that infrastructure investments will act to both create and destroy businesses and jobs associated with their operation, it does not offer a clear prediction about the relative strengths of the enabling and disabling roles of infrastructure investments. In other words, whether infrastructure investments have a stronger enabling or disabling effect is theoretically ambiguous and is therefore an empirical question. To address this, I re-estimate the baseline model using the *Net entry rate*, or the difference between the entry and exit rates, and the *Net job creation rate*, or the difference between the birth job creation and death job destruction rates and present the results in models 1 and 2 of Table 7. A positive (negative) and significant relationship between infrastructure investments and either net creation measure would be suggestive of a stronger net enabling (disabling) role.

Recall that private infrastructure investment is positively and significantly associated with both measures of creation dynamism,

Table 7
GMM results - additional dynamism indicators.

	(1)	(2)	(3)	(4)	(5)
	Net entry	Net job creation	Total job creation	Total job destruction	Net total job creation
DV, lagged 1 year	0.332***	0.148***	0.300***	0.306***	0.247***
	[0.107]	[0.031]	[0.041]	[0.048]	[0.045]
DV, lagged 2 years	0.207***	0.104***	0.170***	0.078**	0.062
	[0.065]	[0.028]	[0.045]	[0.033]	[0.043]
Private infrastructure investment	0.017**	0.010	0.028**	−0.028***	0.035**
	[0.008]	[0.007]	[0.012]	[0.009]	[0.016]
Public infrastructure investment	−0.003	−0.016	−0.038*	0.094***	−0.093***
	[0.024]	[0.020]	[0.022]	[0.029]	[0.032]
Corruption	−0.011	−0.009	0.016	0.011	0.002
	[0.007]	[0.009]	[0.010]	[0.012]	[0.013]
Tax distortion index	−0.070	−0.049	−0.312***	−0.030	−0.314***
	[0.051]	[0.048]	[0.107]	[0.091]	[0.097]
Labor market friction index	−0.201***	−0.075	−0.249**	−0.221*	−0.152
	[0.065]	[0.058]	[0.126]	[0.116]	[0.113]
Government consumption index	−0.100**	−0.026	−0.254***	0.139**	−0.357***
	[0.042]	[0.040]	[0.062]	[0.067]	[0.086]
Citizen ideology	−0.004*	−0.005***	−0.020***	−0.013***	−0.010**
	[0.002]	[0.002]	[0.005]	[0.005]	[0.004]
Economic growth	0.038***	−0.001	0.030	0.003	0.037
	[0.013]	[0.016]	[0.019]	[0.015]	[0.027]
GDP less infrastructure	−0.185	0.370	0.263	−0.952	0.767
	[0.509]	[0.461]	[0.826]	[0.683]	[0.680]
Unemployment rate	−0.084***	−0.007	−0.021	0.270***	−0.295***
	[0.024]	[0.024]	[0.043]	[0.052]	[0.051]
Population density	−0.046**	−0.046***	−0.104***	−0.010	−0.107***
	[0.021]	[0.017]	[0.033]	[0.026]	[0.028]
Foreign population share	0.035***	0.024**	0.104***	0.052***	0.073***
	[0.011]	[0.010]	[0.017]	[0.013]	[0.014]
Human capital	−0.006	−0.012	−0.005	0.014	−0.025
	[0.011]	[0.011]	[0.024]	[0.017]	[0.017]
Academic R&D	−0.000	−0.000**	−0.000	−0.000	−0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
N	1100	1100	1100	1100	1100
Groups	50	50	50	50	50
Long run - private	0.037	0.013	0.052	−0.046	0.051
Long run - public	−0.006	−0.022	−0.072	0.153	−0.134
p(Hansen)	0.12	0.77	0.92	0.15	0.38
p(AR1)	0.00	0.00	0.00	0.00	0.00
p(AR2)	0.38	0.90	0.74	0.23	0.13
p(AR3)	0.26	0.71	0.54	0.33	0.40
Lag limit A	2	1	1	1	1
Lag limit B	6	5	6	3	6
# of instruments	54	54	57	48	57

Dynamic panel system GMM estimates using Stata command xtabond2 (Roodman, 2009a). Italicized variables treated as endogenous and instrumented with their lagged first-differences. The coefficients for the infrastructure investment variables represent their short-run effects, while the long-run multiplier effect of the two infrastructure investment variables on the respective DV are denoted as Long Run Effect - Private and Long Run Effect - Public. p(ARi) is the *p*-value from the Arellano-Bond tests for AR(i) in first differences. By construction, the dynamic panel estimator exhibits first-order serial correlation of residuals in differences, but second-order autocorrelation renders the instruments invalid. p(Hansen) is the *p*-value of the robust Hansen test of over-identifying restrictions. To reduce the bias and potential for false positive results caused by instrument proliferation, the instrument matrix is collapsed and lag limits are introduced that satisfy autocorrelation and over-identification conditions for valid instruments (Roodman, 2009a, 2009b). All models include time dummies and a constant - results omitted for space. Robust standard errors in brackets. See Table 1 for description of the DVs. All *p*-values are based on two-tailed tests.

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

but insignificantly associated with both destruction measures. These results are suggestive that private infrastructure investments exert, on net, a greater enabling function, which would manifest in higher Net entry and Net job creation. Private infrastructure investment is positively and significantly associated with Net entry, providing evidence in favor of the former, and it is positively but not significantly associated with Net job creation. These results, in conjunction with the main results, are strongly indicative of private infrastructure investment primarily serving an enabling role with respect to business establishment creation.

Recall also that public infrastructure investment is negatively and significantly associated with both measures of destruction dynamism, but insignificantly associated with both creation measures. These results are suggestive that public infrastructure investments exert, on net, a greater disabling function, which would manifest in lower Net entry and Net job creation. Public infrastructure investment is indeed negatively associated with both Net entry and Net job creation in Table 7, but neither is statistically significant. Although the main results are indicative of public infrastructure investments serving primarily a disabling role, these results do not point to this as a dominant effect.

Although I am primarily concerned with the creation and destruction of jobs associated with new establishment entry and exit, respectively, infrastructure investments may also encourage firm expansion or contraction, resulting in the creation and destruction of jobs within incumbent establishments. I investigate these possibilities by employing the *Total job creation* rate, or the ratio of employment gains from business expansion and entry in period *t* to total employment in period *t-1* and the *Total job destruction* rate, or the ratio of employment losses from contracting establishments and exits in period *t* to total employment in period *t-1* as the DVs in models 3 and 4 of Table 7, respectively. Furthermore, I explore the effect of infrastructure investments on *Net total job creation*, or the difference between Total job creation and Total job destruction, in model 5.

The results suggest private infrastructure investment is positively and significantly associated with Total job creation, but negatively and significantly associated with Total job destruction. These results point to an overall positive net job enabling effect of private infrastructure investment. Indeed, it is positively and significantly associated with Net total job creation in model 5. The exact opposite is true of public infrastructure investments. That is, public infrastructure investment is negatively and significantly associated with Total job creation, positively and significantly associated with Total job destruction and negatively and significantly associated with Net total job creation. These results are suggestive of a net job disabling effect of public infrastructure investments.

4.4. *Window of opportunity*

Infrastructure investments change the physical environment in a way that provides a window of opportunity for entrepreneurs to enter the market while at the same time closing the window on some existing opportunities. My empirical specification lags infrastructure investments one period relative to the dynamism measures, allowing me to estimate the short-run temporal effect as well as the long-run multiplier effect of infrastructure investments on dynamism. To further assess the temporal effects of infrastructure investments, I explore the inclusion of additional lags of private infrastructure investment and public infrastructure investments in the Entry rate and Exit rate models, respectively. I present the result in Appendix Tables A2 and A3. Model 1 in each table reproduces the baseline estimates from Table 3 for comparison. Model 2 re-estimates this model for the sample of observations for which five lags of infrastructure investment are available. Models 3–6 each introduce one additional lag of the respective infrastructure investment variable.

The results in Table A2 show that the positive and significant effect of private infrastructure investment in period *t-1* is robust when including additional lags and the coefficient is relatively stable. The long-run effect; however, appears to weaken as additional lags are included, a result attributable to the negative, although insignificant, sign on most of the additional lags. The results in Table A3 show that the positive effect of public infrastructure investment on Exit rate loses significance once additional lags are included in the specification. With the exception of the two-year public infrastructure investment lag in models 4 and 5, which enter positively, none of the public infrastructure lags are significant in models 3–6 and the various lags often take different signs. The lags are, however, jointly significant in model 6, which is the most preferred specification according to the MMSC-BIC value (Andrews and Lu, 2001), and the estimated long-run effect of public infrastructure investment on the Exit rate is 0.116, similar to the long-run effect from the baseline model.

Overall, I interpret these results as suggestive that private infrastructure investments may provide a window of opportunity for new firm creation, but the effects are amplified over time, as state-level business entry rates are somewhat persistent. Public infrastructure investments, meanwhile, may close the window of opportunity for some incumbent businesses, an effect that tends to accumulate over time, as business exit rates are also somewhat persistent.

5. Discussion

5.1. *Policy implications*

A growing body of evidence suggests that the U.S., long considered the most entrepreneurial and dynamic economy in the world, (Schramm, 2004), has become increasingly less dynamic in recent decades, a trend that is pervasive across industries, regions, and firm sizes (Decker et al., 2014; Decker et al., 2016b; Hathaway and Litan, 2014). Concerned with the potential negative productivity, growth and job creation consequences of the slowdown in dynamism (Decker et al., 2016a, 2016b), policymakers may be tempted to increase public infrastructure investments in an effort to counter this trend. My results suggest, however, that public infrastructure investments may be a poor mechanism to enable new business development and organic job growth, but may instead propel more business exits and permanent job losses. Private infrastructure investments, however, facilitate the creation of new businesses and jobs. My results should not be construed as suggesting that government should avoid all infrastructure investments because the impact of public infrastructure investments on dynamism is heterogeneous and infrastructure investments potentially confer other benefits.[32] Rather, the take-away is that public infrastructure investments involve trade-offs and are not a panacea for all economic

[32] For the interested reader, there is a substantive literature on the effects of public infrastructure (e.g., Conrad and Seitz, 1994; Gramlich, 1994; Munnell, 1992; Pereira and Andraz, 2013).

woes (Hulten and Schwab, 1993). Faced with increasingly constrained budgets, policymakers should carefully evaluate the potential costs and benefits when evaluating potential public investment opportunities and avoid the desire to build "white elephant infrastructure projects" that are highly visible but rarely confer social surplus (Glaeser, 1998). If encouraging entrepreneurship and job creation are primary policy objectives, then policies that encourage private infrastructure investment, perhaps through public-private partnerships and/or the reducing regulatory red tape and other market distorting policies, are likely to be more effective stimulants.

5.2. Practitioner implications

Advances in logistics and telecommunications technologies have reduced the costs of transportation, communication and information acquisition (Christensen and Drejer, 2005; McCann and Sheppard, 2003), reducing the need for firms to locate in close proximity to well-developed infrastructure as a means to minimize the costs of moving goods and gain access to information and skilled labor pools (Glaeser, 1998; Hummels, 1999; McCann and Sheppard, 2003). As the U.S. continues its transition to a knowledge-based economy, firms are becoming more reliant on intellectual capabilities and less reliant on physical inputs such as infrastructure (Powell and Snellman, 2004). With the exception of entrepreneurs entering transportation-reliant sectors such as raw materials and agricultural product production (Ferreira et al., 2016; Hummels, 1999), public infrastructure is unlikely to be a major factor in the regional location decision of most entrepreneurs. Many entrepreneurs instead initially launch their businesses near home where they have tacit knowledge of the local market (Hayek, 1945; Stam, 2007). While most firms become embedded in their home region, some high-growth startups encounter local resource and/or capability constraints that lead them to relocate to an area where these constraints are less binding and enable them to better manage new spatial configurations (Stam, 2007). My results suggest that states that provide a business environment that encourages private infrastructure investments are more attractive to entrepreneurs and may therefore provide growing firms with access to the resources and capabilities that they require to take their businesses to the next level. Appendix Table A4 provides the mean annual per capita private infrastructure investment by state for the periods 1992–2000, 2001–2005, 2006–2010, and 2011–2015.

5.3. Limitations & potential extensions

Below I note several limitations of the empirical analysis that should be viewed as cautionary notes and provide an impetus for future research. First, telecommunications infrastructure such as broadband internet has been suggested as an important factor for entrepreneurship (Cumming and Johan, 2010; Guillén and Suárez, 2001; Mack and Rey, 2014), but my data does not account for telecommunications infrastructure investment because of a lack of comparable state-level data across the observation period. As better data become available, it would be useful to revisit the analysis.

Next, my results apply to the U.S. states. The underlying processes may differ, however, at a more granular subnational level such as the county or metropolitan statistical area. For example, infrastructure investments in large states such as California may be beneficial to entrepreneurs in the area where the infrastructure is developed (e.g., Los Angeles), but have little effect on entrepreneurs in distant parts of the state (e.g., Sacramento). The processes may also differ in other country contexts,[33] particularly in lower income countries where the formal economy and infrastructure stock are relatively undeveloped (Pereira and Andraz, 2013), as the law of diminishing marginal returns suggests that the marginal impact of infrastructure investment should be greater when starting from a low baseline infrastructure stock. Additional research that considers the relationship between infrastructure investment and dynamism at the local level and/or different country contexts would be informative.

Lastly, previous research suggests that environmental factors such as institutions (Boudreaux et al., 2017; Gohmann et al., 2008), human capital (Qian et al., 2013) and infrastructure (Audretsch et al., 2015) may differentially affect entrepreneurial activity across industries. There is also evidence that public infrastructure investment may be more beneficial to certain industries (Pereira and Andraz, 2003). My analysis considers the influence of infrastructure investment on economy-wide dynamism, but those investments may affect dynamism across industries in a heterogeneous manner. Examining the effect of infrastructure investment on industry-level dynamism would be an excellent extension.

Declarations of interest

None.

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[33] Reynolds et al. (1994) found that similar underlying processes affecting regional firm formation were at work in several Western European countries and the United States in the 1980s.

Appendix A

Table A1
Total infrastructure investment system GMM results.

	(1)	(2)	(3)	(4)
	Entry rate	Birth job creation	Exit rate	Death job destruction
DV, lagged 1 year	0.628***	0.203***	0.630***	0.150***
	[0.045]	[0.046]	[0.052]	[0.037]
DV, lagged 2 years	0.201***	0.195***		0.081**
	[0.035]	[0.035]		[0.032]
Total infrastructure investment	0.011**	0.010**	0.010*	0.005
	[0.004]	[0.005]	[0.005]	[0.004]
Corruption	−0.002	−0.003	0.005	0.006
	[0.005]	[0.008]	[0.006]	[0.008]
Tax distortion index	−0.012	−0.076	−0.027	−0.088
	[0.032]	[0.060]	[0.040]	[0.057]
Labor market friction index	−0.141***	−0.167***	−0.053	−0.097
	[0.045]	[0.063]	[0.060]	[0.074]
Government consumption index	−0.025	−0.015	0.015	−0.031
	[0.029]	[0.035]	[0.033]	[0.031]
Citizen ideology	−0.003	−0.010***	−0.007**	−0.008***
	[0.002]	[0.002]	[0.003]	[0.003]
Economic growth	0.024***	0.002	−0.012	0.001
	[0.009]	[0.012]	[0.010]	[0.009]
GDP less infrastructure	−0.261	−0.316	−0.275	−0.478
	[0.253]	[0.465]	[0.281]	[0.400]
Unemployment rate	0.019	0.046*	0.102***	0.051*
	[0.014]	[0.026]	[0.025]	[0.028]
Population density	−0.025*	−0.048***	−0.024	−0.030*
	[0.014]	[0.016]	[0.016]	[0.016]
Foreign population share	0.027***	0.053***	0.034***	0.050***
	[0.010]	[0.009]	[0.010]	[0.008]
Human capital	0.002	−0.004	0.013	0.008
	[0.008]	[0.014]	[0.009]	[0.013]
Academic R&D	0.000	−0.000	−0.000	−0.000
	[0.000]	[0.000]	[0.000]	[0.000]
N	1100	1100	1100	1100
Groups	50	50	50	50
Long run effect - infrastructure	0.06	0.02	0.03	0.11
p(Hansen)	0.49	0.14	0.12	0.48
p(AR1)	0.00	0.00	0.00	0.00
p(AR2)	0.40	0.38	0.09	0.87
p(AR3)	0.30	0.26	0.32	0.53
Lag limit A	1	1	2	1
Lag limit B	7	6	10	3
# of instruments	52	50	55	44

Dynamic panel system GMM estimates using Stata command xtabond2 (Roodman, 2009a). Italicized variables treated as endogenous and instrumented with their lagged first-differences. Total infrastructure investment is the sum of public and private investment per capita. The coefficients for the infrastructure investment represents the short-run effect, while the long-run multiplier effect is denoted as Long Run Effect - Infrastructure. (ARi) is the *p*-value from the Arellano-Bond tests for AR(i) in first differences. By construction, the dynamic panel estimator exhibits first-order serial correlation of residuals in differences, but second-order autocorrelation renders the instruments invalid. p(Hansen) is the *p*-value of the robust Hansen test of over-identifying restrictions. To reduce the bias and potential for false positive results caused by instrument proliferation, the instrument matrix is collapsed and lag limits are introduced that satisfy autocorrelation and over-identification conditions for valid instruments (Roodman, 2009a, 2009b). Model 3 excludes the 2nd lag of the DV as it is statistically insignificant; however, to avoid second-order autocorrelation, the differenced instrumental variables are lagged 2 periods relative to the endogenous variables. All models include time dummies and a constant - results omitted for space. Robust standard errors in brackets. All *p*-values are based on two-tailed tests.

*** $p < 0.01$.
** $p < 0.05$.
* $p < 0.1$.

Table A2
Lag analysis - effect of private infrastructure investment on entry rate.

	(1)	(2)	(3)	(4)	(5)	(6)
	Entry rate	Entry rate	Entry rate	Entry rate	Entry rate	Entry rate
Entry rate (t-1)	0.620***	0.603***	0.618***	0.624***	0.621***	0.590***
	[0.045]	[0.047]	[0.047]	[0.043]	[0.043]	[0.053]
Entry rate (t-2)	0.193***	0.190***	0.201***	0.207***	0.205***	0.205***
	[0.036]	[0.038]	[0.041]	[0.039]	[0.039]	[0.041]
Public infrastructure investment (t-1)	0.010	−0.001	−0.003	−0.003	−0.003	−0.007
	[0.016]	[0.013]	[0.012]	[0.011]	[0.012]	[0.011]
Private infrastructure investment (t-1)	0.011*	0.015***	0.018***	0.016**	0.016**	0.013**
	[0.006]	[0.005]	[0.006]	[0.006]	[0.007]	[0.006]
Private infrastructure investment (t-2)			−0.008	−0.007	−0.006	−0.006
			[0.006]	[0.008]	[0.009]	[0.008]
Private infrastructure investment (t-3)				−0.004	−0.005	−0.005
				[0.009]	[0.010]	[0.011]
Private infrastructure investment (t-4)					0.002	0.004
					[0.004]	[0.006]
Private infrastructure investment (t-5)						−0.005
						[0.006]
Private lags	1	1	2	3	4	5
Public lags	1	1	1	1	1	1
p(Joint Test Private Infrastructure Lags)	0.07	0.00	0.01	0.02	0.02	0.08
Long run effect	0.057	0.073	0.051	0.028	0.037	0.002
MMSC-BIC	−61.41	−59.65	−65.60	−70.83	−75.59	−79.30
Sample	Unconstrained	Constrained	Constrained	Constrained	Constrained	Constrained
N	1100	1000	1000	1000	1000	1000
Groups	50	50	50	50	50	50
p(Hansen)	0.84	0.74	0.89	0.96	0.98	0.99
p(AR1)	0.00	0.00	0.00	0.00	0.00	0.00
p(AR2)	0.37	0.39	0.42	0.51	0.48	0.66
# of instruments	57	56	58	60	62	63

Dynamic panel system GMM estimates using Stata command xtabond2 (Roodman, 2009a) using various lag structures of the main independent variable (IV) of interest, Private infrastructure investment. Model 1 reproduces the baseline result from Table 3, model 1. Models 2 constrains re-estimates the baseline model, constraining the sample to the observations for which 5 lags of the IV are available so that the results are comparable across models. Models 3–6 each introduce an additional lag of the IV (e.g., models 3 and 6 include 2 and 5 lags of the IV, respectively). p(Joint Test Private Infrastructure Lags) is the *p*-value from a joint test of significance of all of the private infrastructure investment lags in the specified model. The coefficients for each lag represent the short-run effect of private infrastructure investment that period on Entry rate in period t. The long-run multiplier effect of private infrastructure investment on Entry rate is given by Long Run Effect. MMSC-BIC is the model and moment Bayesian information selection criteria (Andrews and Lu, 2001). Results for the control variables and constant are omitted for space -see Table 3 for additional details on the model specification. Robust standard errors in brackets. All *p*-values are based on two-tailed tests.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table A3
Lag analysis - effect of public infrastructure investment on exit rate.

	(1)	(2)	(3)	(4)	(5)	(6)
	Exit rate	Exit rate	Exit rate	Exit rate	Exit rate	Exit rate
Exit rate (t-1)	0.626***	0.641***	0.616***	0.622***	0.612***	0.576***
	[0.062]	[0.062]	[0.066]	[0.057]	[0.059]	[0.057]
Private infrastructure investment (t-1)	−0.001	0.003	0.004	0.004	0.003	0.002
	[0.006]	[0.006]	[0.007]	[0.007]	[0.007]	[0.007]
Public infrastructure investment (t-1)	0.041**	0.023*	−0.032	−0.036	−0.033	−0.034

(continued on next page)

Table A3 (*continued*)

	(1)	(2)	(3)	(4)	(5)	(6)
	Exit rate	Exit rate	Exit rate	Exit rate	Exit rate	Exit rate
	[0.019]	[0.014]	[0.035]	[0.030]	[0.030]	[0.045]
Public infrastructure investment (t-2)			0.062	0.069*	0.069*	0.078
			[0.041]	[0.039]	[0.035]	[0.051]
Public infrastructure investment (t-3)				−0.006	0.002	0.003
				[0.012]	[0.016]	[0.017]
Public infrastructure investment (t-4)					−0.007	−0.015
					[0.013]	[0.022]
Public infrastructure investment (t-5)						0.017
						[0.016]
Private lags	1	1	1	1	1	1
Public lags	1	1	2	3	4	5
p(Joint Test Public Infrastructure Lags)	0.03	0.09	0.19	0.30	0.34	0.04
Long run effect	0.110	0.064	0.077	0.071	0.081	0.116
MMSC-BIC	−50.14	−49.45	−52.92	−60.42	−58.87	−74.38
Sample	Unconstrained	Constrained	Constrained	Constrained	Constrained	Constrained
N	1150	950	950	950	950	950
Groups	50	50	50	50	50	50
p(Hansen)	0.32	0.28	0.32	0.60	0.33	0.96
p(AR1)	0.00	0.00	0.00	0.00	0.00	0.00
p(AR2)	0.09	0.12	0.12	0.10	0.10	0.12
# of instruments	56	53	55	57	59	60

Dynamic panel system GMM estimates using Stata command xtabond2 (Roodman, 2009a) using various lag structures of the main independent variable (IV) of interest, Public infrastructure investment. Model 1 reproduces the baseline result from Table 3, model 5. Models 2 constrains re-estimates the baseline model, constraining the sample to the observations for which 5 lags of the IV are available so that the results are comparable across models. Models 3–6 each introduce an additional lag of the IV (e.g., models 3 and 6 include 2 and 5 lags of the IV, respectively). p(Joint Test Public Infrastructure Lags) is the *p*-value from a joint test of significance of all of the public infrastructure investment lags in the specified model. The coefficients for each lag represent the short-run effect of public infrastructure investment that period on Exit rate in period t. The long-run multiplier effect of public infrastructure investment on Exit rate is given by Long Run Effect. MMSC-BIC is the model and moment Bayesian information selection criteria (Andrews and Lu, 2001). Results for the control variables and constant are omitted for space -see Table 3 for additional details on the model specification. Robust standard errors in brackets. All *p*-values are based on two-tailed tests.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table A4

Mean annual per capita private infrastructure investment by state.

State	1992–2000	2001–2005	2006–2010	2011–2015
Alaska	11.6	8.6	7.3	5.7
Alabama	9.3	8.5	12.4	6.3
Arkansas	6.2	6.3	6.4	6.7
Arizona	13.7	12.9	12.7	7.8
California	9.0	7.1	5.3	5.0
Colorado	14.2	11.2	10.6	11.6
Connecticut	10.1	8.4	8.9	5.8
Delaware	9.8	6.2	5.2	6.8
Florida	9.9	9.6	8.8	6.2
Georgia	11.0	10.6	8.6	7.8
Hawaii	16.2	7.9	7.3	10.1
Iowa	9.4	11.3	12.9	20.6
Idaho	9.5	9.5	10.5	6.6
Illinois	8.3	7.6	8.4	6.9
Indiana	13.0	10.8	13.9	8.4

(*continued on next page*)

Table A4 (*continued*)

State	1992–2000	2001–2005	2006–2010	2011–2015
Kansas	9.1	8.6	8.8	11.0
Kentucky	9.5	8.1	6.1	7.8
Louisiana	10.1	7.4	14.2	23.1
Massachusetts	12.1	11.0	10.7	11.3
Maryland	8.1	9.3	7.6	6.0
Maine	8.4	6.3	7.1	4.3
Michigan	9.1	7.2	5.8	5.2
Minnesota	8.8	7.9	5.7	7.9
Missouri	8.7	9.3	8.2	6.8
Mississippi	7.2	6.8	8.9	6.9
Montana	9.0	6.3	5.3	10.3
North Carolina	10.6	8.4	7.5	6.7
North Dakota	10.8	8.3	10.2	31.7
Nebraska	10.0	13.6	11.6	8.9
New Hampshire	9.4	9.8	9.4	5.8
New Jersey	8.8	7.2	6.7	4.8
New Mexico	7.2	6.6	14.7	10.0
Nevada	33.6	27.5	29.4	16.4
New York	6.9	6.9	9.4	12.0
Ohio	10.1	8.4	7.8	7.2
Oklahoma	6.4	8.9	7.8	9.3
Oregon	12.5	9.1	8.7	12.7
Pennsylvania	7.8	6.8	6.9	5.4
Rhode Island	4.7	7.8	7.8	4.1
South Carolina	10.4	9.0	8.1	8.6
South Dakota	7.6	11.5	12.7	8.8
Tennessee	10.6	8.8	8.3	8.8
Texas	10.6	9.7	11.6	14.8
Utah	15.1	10.2	13.8	10.3
Virginia	9.9	9.8	7.7	5.7
Vermont	7.9	10.0	5.8	8.1
Washington	10.8	9.0	10.1	8.7
Wisconsin	8.2	7.8	7.6	6.9
West Virginia	3.7	3.9	5.3	3.8
Wyoming	6.8	6.9	10.6	13.5

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