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What if you build it and they don't come? How the ghost of transit past haunts transit present☆

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A R T I C L E I N F O

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A B S T R A C T

In the last quarter-century, both Bogota and Jakarta built bus rapid transit systems. Bogota's is widely credited as a success; Jakarta's not. To understand why, we look back more than a century to the roots of initial transit investments in these two cities. We credit Bogota's current success in large part to pre-existing land use patterns – commercial streets, residential density, and pedestrian-friendly infrastructure – determined by its streetcar system of the 1910s that remain hospitable to successful transit today. Similarly, we suggest that Jakarta's struggles stem from the difficulty of adapting areas built for private transport, particularly the car, to public transit. We conclude by using these insights to look forward and contemplate more generally whether and how transit can succeed in areas constructed during the period of auto hegemony and its pedestrian-unfriendly land uses.

Many years ago, a friend of one of the authors worked as the assistant to the assistant for a man ranked under ten on the Forbes 500 list. This Manhattan dweller's usual choice of transport was a chauffeured private car – except when going to and from hockey games, in which case he took the subway. This willingness of even the richest of the rich to use the subway highlights what the subway delivers: speeds that exceed that of a private car. Furthermore, subways can provide these better-than-traffic speeds for very large numbers of people. Subways manage this feat because they do not compete with traffic.

While the average commuter's public transit first choice might be a train or subway, cash-strapped planners frequently recommend buses to politicians. Relative to the high fixed costs for trains, buses are cheap. Also unlike subways, planners can immediately re-route buses. However, commuters rationally perceive them as slow. Even at its very best, a bus can never exceed the speed of a private car.[1] On a congested road, as a bus stops to pick up and drop off passengers, the bus is always slower than a private car.

Bus rapid transit (BRT) holds out hope of breaking this cost-versus-speed logjam: cheaper than rail, but faster than a private car on a congested road. BRT does this by running buses on dedicated rights-of-way. That is, buses – and sometimes very long ones – run on special lanes or routes dedicated exclusively for these vehicles. To further speed boarding, BRT systems usually require riders to pay before boarding, and thus allow expedient entrance and exit through all doors.

Does such a cheaper, speedy alternative really exist? Two recent excellent research projects evaluate BRT's success in two major world cities on two different continents (Tsivanidis, 2019; Gaduh et al., 2020). Both analyze recently built systems – Bogota, Colombia's 2000 system and Jakarta, Indonesia's 2004 one – with careful reduced-form work followed by thoughtful general equilibrium analysis. Riding roughshod over context and nuance, the comparative bottom line is: Bogota, a success; Jakarta, not so much.

An astoundingly high share of Bogota's population – almost seven in ten residents – rides the BRT (Hudson, 2017). The new system reduced transit times and improved outcomes for both low- and high-skilled commuters. Perhaps there is not, after all, a trade-off between speed and cost in transit.

In contrast, Jakarta's system has failed to launch – and not for a lack

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[1] In developing countries, the picture is frequently even worse, without formal bus stops and attendant congestion and chaos.

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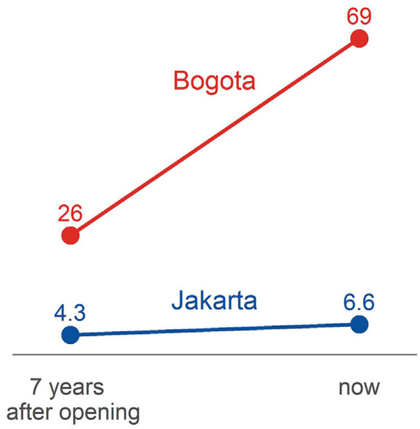


Note: This figure reports the mode share, or the share of transit users who regularly use this mode. The initial values for Bogota ("after seven years of operation") and Jakarta (2010) come from Gaduh et al. (2020, p. 3). The final value for Bogota (2017) is from Hudson (2017). The final value for Jakarta (2017) is from a survey of women riders (Witoelar et al., 2017, Figure 7.1) and is, in Alex Rothenberg's estimation "probably an overestimate."

Fig. 1. Bus Rapid Transit Ridership in Bogota Dwarfs That in Jakarta (Gaduh et al., 2020; Hudson, 2017; Witoelar et al., 2017).

of ambition. With twelve primary routes, more than 100 stations, and roughly 250 km of route, Jakarta hosts the world's largest BRT system (Institute for Transportation Development and Policy, 2019). Record-breaking length notwithstanding, its creation not only failed to decrease commute times for residents near BRT stops but also yielded increased auto travel times on the very roads that the BRT serves (Gaduh et al., 2020).

The difference in outcomes between these two cases is remarkable. Fig. 1 shows the share of the metropolitan population in these two areas riding BRT within seven years of opening and "today" (2017). Seven years after system opening, more than one in four people in Bogota rode the BRT; fewer than one in twenty did in Jakarta. As of today – after sixteen years of BRT existence in Jakarta and twenty-two in Bogota – ridership in Jakarta remains relatively low.

Why this great divergence? In this article, we offer a hypothesis that can explain why BRT succeeded in Bogota and struggled in Jakarta. We look not to the specifics of each modern program, but back at least one hundred years for the roots of divergence. Our hypothesis also explains why transit construction that post-dates initial neighborhood development is so infrequently successful. We conclude by discussing how determinative past decisions are for outcomes today. What do transit of the past and buildings of the past mean for urban areas of the future?

1. A hypothesis of the lingering past

In one of the most famous quotes in American literature, William Faulkner writes in *Requiem for a Nun* that "the past is never dead. It's not even past" (Faulkner, 1951). In Faulkner's work, the past is the lingering shade of both the great rupture of the Civil War and ancestral deeds and misdeeds. These elements of the past form, define, and delimit behavior today. Faulkner's characters have no agency independent of the past. To Faulkner, the past is the present – it defines the present before the present has even arrived.

But what does Faulkner tell us about bus rapid transit in Colombia and Indonesia? Let us first step backwards to the rise of "rapid" transit. Until the late 1800s, the modal options for intraurban transit were limited to walking, riding a horse, or riding in some sort of carriage. These last two options were quite expensive and poorly suited for taking more than a very limited number of people at a time (Fischel, 2004; Warner, 1978).

The end of the 1800s yielded two notable advances in transportation technology that gave ordinary working people a way to travel within the city for a price they could conceivably afford.[2] The first of these advances was the insight that a regularly scheduled route, in combination with the economies of scale in literal horsepower afforded by taking passengers on rails rather than wheels, yielded a viable business enterprise. This combination created the horsecar – a horse-drawn, bus-like carriage that ran on rails.[3] Horsecars carried up to forty people, and moved at the heretofore unknown blistering speed of six to eight miles per hour (Jackson, 1985, p. 39).

The second innovation in transit was the invention of the electrified streetcar. While the horsecar was an advance, it retained major drawbacks. Horses frequently got sick, decimating the source of power. Horse poop created malodorous environmental problems (Morris, 2007). In 1888, responding to demand for an alternative power source, Frank Sprague was the first to demonstrate a practical, scalable electric rail technology in Richmond, Virginia (Morris, 2007; Campion et al., 2000). Sprague's new electric streetcars more than doubled the speed of the horsecar, sometimes exceeding 20 miles per hour (Jackson, 1985, p. 109).[4]

The transit boom that followed – and here we use "transit" rather than "public transit" to highlight the fact that virtually all of this investment was done by private actors with private aims – extended well beyond large metropolitan areas. While cities such as New York and London built systems we still know today, cities of all sizes laid down rails. For instance, street railways served more than 211 Massachusetts "towns" in 1910 (Jackson, 1985, p. 111). Peoria, Illinois, a city of somewhat more than 50,000 people in 1900, had multiple streetcar lines (Tarter, 2016; US Census Bureau, 1900). Thus, there was profit to be made in the electrification of transport in towns of all sizes.

By making it affordable to go beyond the roughly two-mile square that characterized most pre-transit cities, the streetcar expanded the viable envelope of the city and democratized movement. Workers were no longer confined to living within a reasonable walking distance of their workplace. Non-workers were freed from living very near to shops and other daily-use facilities. Urban residents took advantage of this new freedom by moving out to new streetcar suburbs. These were areas outside the built-up areas of the city, but proximate to the streetcar stop. To give a few examples among thousands, the Chevy Chase neighborhood on the border of Washington, DC and Maryland was a streetcar creation. The cities of Burbank and Glendale just outside of Los Angeles owe their existence to the streetcar, as does Bogota's now fashionable Chapinero neighborhood.

Land use in these original streetcar suburbs took a very particular form, carefully delimited by the need to walk to the streetcar stop. Thus, development was usually concentrated in a one-half mile radius of the stop. At least in the US, development very close to the streetcar tended to be multi-family and commercial. Development slightly further away was single-family residential.

But streetcars did not just influence outlying residential neighborhoods. By freeing people from residential locations quite so proximate to work, streetcars also transformed downtowns, turning these mixed commercial and residential areas to almost exclusively commercial ones (as illustrated in Heblich et al. (forthcoming)). Streetcars networks usually met in downtowns. Because of the hub-and-spoke network, even commuters whose destination was outside of downtown passed through downtown. Thus, streetcars are widely credited with the rise of the

[2] We omit, in this discussion, the rise of the steam engine during the 18th century. Undoubtedly, the steam engine's rise to prominence led to very early suburbanization. Steam railroads (a 19th century phenomenon), however, were sufficiently expensive that the suburbanization they engendered was limited to the quite wealthy (Jackson, 1985).

[3] For brevity, we omit the omnibus, which is the regularly scheduled part of the insight, without the rails.

[4] What we call "streetcars" in this paper are also known as "trams" or "electric railroads." For simplicity, we stick to "streetcar."

department store – a large store where consumers could purchase a variety of goods in many departments and from which take their purchases home on the streetcar (Jackson, 1985). You (2020) provides compelling evidence of this type of retail centralization and consolidation in early 1900s Boston.

The rise of the electric streetcar, however, barely pre-dated the rise of the automobile. Like canals and the betamax video cassette, the electric streetcar was dominant and swiftly superseded. Electric streetcars rapidly replaced horse-drawn cars throughout the US in the first decades of the twentieth century, as well as in much of Europe and larger cities in Africa, Asia, and South America (The Editors of Encyclopaedia Britannica, 2018). Shortly after this replacement, the motor coach – or bus – became an affordable alternative for operators. With competition from both the bus and the private car, streetcar companies fell into a vicious cycle of declining demand and lowered service quality. The end result of this cycle was usually the municipalization of some transit services and the abolition of electric streetcar services (Yago, 1984; Tillitson, 1997). By the 1950s and 1960s, many cities ripped streetcar tracks out of the road – frequently the same roads that had been created by those tracks thirty to fifty years before.

However, while canals have filled in, betamax tapes are extinct, and streetcar tracks have been largely pulled out of roads, the urban pattern the streetcar dictated has largely endured. This speaks to a larger urban pattern: cities, once formed, mutate only rarely and only through great upheaval. Many of the same paths on which the Romans built major roadways two millennia ago continue to demarcate major roads today. Historian Victor Von Hagen characterizes Roman roads as "the most enduring monuments of Rome" (Von Hangen, 1967). Michaels and Rauch (2019) show that Roman roads influenced sub-optimal urban development in France until 1800.

While it is in many ways difficult to top the Roman Empire, Ancient Rome is far from the only example of the persistent past. In a study of Los Angeles, Redfearn (2009) shows that the modern-day location of employment centers is as closely related to hundred-year-old employment center locations as they are to modern freeway locations. Ahlfeldt et al. (2020) show that the density of service employment today is linked to subway investments in the late 1800s and early 1900s. In a similar vein, the patterns of early industrial pollution in England, gone since the 1970s, continue to explain modern neighborhood segregation (Heblich et al., 2020). And looking across cities, Bleakley and Lin (2012) show that canoe portage routes from the 1700s generated a key portion of the current American urban pattern.

But the initial physical layout of roads and buildings determined by streetcar economics is merely the beginning. This initial pattern of development determines a whole cascade of future events: follow-on infrastructure such as roads and bridges, the quantity and quality of public space such as parks, and the type and restrictiveness of land use regulation.

We now turn to land use regulation, which we believe is a key instrument for maintaining urban physical structure. Land use regulation first appeared in Germany in the late 1800s with the passage of Frankfurt's 1891 zoning law (Burgess, 1994). Zoning as we know it today as limitations on use and structure bulk, did not arrive in North American until the late 1910s, well after the rise of streetcars. After its initial appearance in New York in 1916, zoning was adopted very quickly across the country. By 1922, the Department of Commerce had produced the Standard State Zoning Enabling Act, described by Fischel (2004) as "one of the most successful 'model statutes' of all time" (Weiss, 1987).[5]

The extent to which zoning limits the type and quality of structure depends greatly on whether it pre- or post-dates initial construction. When zoning pre-dates construction, it limits – to varying degrees, depending on law and politics – what can be built, the size of land one can build on, the use of the resulting structure, and myriad other features. Zoning's role in limiting both what and how much is built is well-documented in the economics literature. Gyourko and Molloy (2015) provide an overview, while Glaeser and Gyourko (2002), Joseph and Summers (2008), and Chakraborty et al. (2010) provide specific examples.

However, when zoning is promulgated in areas where it post-dates construction – the case for most areas built under the influence of the streetcar – it largely codifies what has already been built. When it does not codify the type of structure already built, it almost always grandfathers in the existing use or structure. From a political economy point of view, this kind of grandfathering is natural: it would be difficult to garner support for zoning if it were to require key urban players to tear down existing non-compliant buildings.

Therefore, the addition of zoning to already-built areas generally reinforces the land use pattern that pre-dated the zoning. Less densely built areas that are then zoned for low density stay low density. In contrast, already-built dense residential or commercial areas that are zoned for density can remain so. Alternatively, they can become less dense through decay. They can also become less dense through new construction, since owners almost always have the right to build *less* densely than mandated. This ability to build less is due to the fact that zoning usually binds on size maxima, not size minima (with minimum lot size and parking spots some key exceptions to this rule). However, economics rarely favors tearing down dense construction to build less densely. Thus, persistence of the initially built structures tends to keep such areas dense.[6]

Brooks and Lutz (2019) offers evidence for this type of chain of events. In the 1890s, Los Angeles County had the world's longest streetcar network. It was largely constructed by Henry Huntington, the nephew of a Gilded Age robber baron who inherited his uncle's fortune and married his uncle's wife. Huntington faced few capital limits on his streetcar construction and viewed his transit enterprise as a way of enriching his land development and electricity enterprises (stockholders participating in only one of these three ventures did not see this value-maximizing as working their favor and sued; see Friedricks (1992)). Per capita ridership in this system peaked around 1920. Already in 1922, Los Angeles transit firms put buses, rather than streetcars, on new routes.

Researchers credit the Pacific Electric system, the inter-urban portion of the transit system, with vastly expanding the borders of the urban area, joining the Pacific Ocean and the foothills with the main business district downtown.[7] Our empirical work with Lutz picks up when small-area population data become available in 1940. Using census tract data on population density paired with property-level data on distance to the streetcar, we find about 1,000 more people per square kilometer at one-third of a kilometer to the streetcar than at three times this distance to the streetcar.

As in most of the rest of the world, the streetcar's reign in Los Angeles was mighty and brief. Scenes from Harold Lloyd's 1923 movie *Safety Last* gives some intuition as to the streetcar's demise. Lloyd's hero continually and unsuccessfully tries to board a streetcar, and is constantly expelled by the throngs already on the train. Finally, hanging tenuously

[5] There is also a more dim view of early zoning as a primarily exclusionary instrument. See Rothstein (2017) for the United States and Myers (2003) for South Africa.

[6] Harari (2020) points out a more general relationship between land use regulation and city shape: more permissive regulation leads to more compact cities. Of course, the extent to which land use regulation shapes outcomes depends centrally on the type and quality of its enforcement. Rukmana (2015) suggests that land use regulation in Indonesia may be chiefly a method for granting favors to those connected to the regime, rather than as a control on undesireable development.

[7] Relatedly, (Gonzales-Navarro and Turner, 2018, Sep.) use light at night to study subways' impact over time and find that subways increase decentralization.

off the side of a streetcar, he tries to lunge into a much faster passing auto (the lunge was also unsuccessful).

Like Lloyd, Angelenos lunged en masse – and more successfully – to the car. And the more cars on the road, the slower the streetcar, since it had no dedicated lane. In response to the declining fortunes of transit operators, the city took control of most bus lines in 1957 (Los Angeles Times Staff, 1958). Half a decade later, in 1963, the city ripped out the last streetcar rails from the ground: the death knell for a system in slow decline for at least forty years.

Given the obliteration of this transit system, it came as a surprise to us to find that the density pattern initially determined by the streetcar in the 1890s in Los Angeles is as strong today as it was in 1940 when we first measure it. Fig. 4(a) shows the relationship between population density (measured at the tract level) and distance to the streetcar (measured at the property level) in 2010. Each point in this figure is the average of roughly 400 individual properties. The steep decline in population density with distance to the streetcar is obvious without any statistical analysis. Areas very close to the streetcar have between five and six thousand people per square kilometer. Already in areas about 1 km from the streetcar, the average density falls substantially to under 4,000 people per square kilometer. These "far from the streetcar" places are generally those that were developed later, where driving, rather than walking, drives a more spread out and less intense land use pattern.[8]

In Fig. 4(b), we show that this relationship has diminished little, if at all, over time. This figure reports time (rather than distance) on the horizontal axis. The vertical axis remains population density. The top line shows the average population density for properties within 0.3 km of a streetcar from 1940 to 2010. Other lines report population density over time at different distances from the streetcar (see label at right). We note two key findings. First, in all decades 1940 to 2010, density declines steeply with distance from the streetcar. In all years, the shortest distance (0.3 km) is the top line, the longest distance we display (3 km) is the bottom line, and lines are in rank order by distance. This rank order appears in the graph because the underlying physical densities are in rank order. Second, while places at all distances from the streetcar become more dense over time (all lines slope upward), the negative relationship between distance to the streetcar and density remains for all years we observe. Statistically, we cannot reject that the relationship between distance to the streetcar and population density is as strong in 2010 as it was in 1940.

After we document the persistence of density, we use data from Los Angeles's 1922 zone code to show that zoning in already built areas ratifies what builders already constructed. Zoning arrived in Los Angeles in 1922, at the beginning of the streetcar's long slow decline. While earlier, limited laws regulated the location of specific commercial activity, the 1922 regulation is widely recognized as Los Angeles's first overall zoning statute (Kolnick, 2008). Brooks and Lutz (2019) show that the 1922 zoning limitations ratified a pattern of more commercial activity near streetcar stops.

Given this, it became clear to us that current transit and infrastructure decisions neither operate nor succeed independent of the past. When Los Angeles returned to public transit in the early 2000s, it built transit routes largely along the same routes that the initial system set out over one hundred years earlier. We believe that land use along transit routes – set in the late 1890s and early 1900s – is enormously influential for modern transit.

Thus, we have laid out one particular channel – initial density, reinforced and ratified by zoning – for the lingering past to influence the present. There are surely also other ways in which the past continues to exert its influence. One potential explanation for the long shadow of the past is that buildings themselves are quite persistent. Undoubtedly, lingering buildings do continue to define urban areas. In Brooks and Lutz (2019), we confirm that this is in part true. Density is greater near streetcars today in part because structures built more than three-quarters of a century ago to fit the economics of the streetcar persist. However, we see just as strong a relationship between distance to the streetcar and structures built after 1963 – when the streetcar rails were torn out of the ground – as we do for structures built before 1963. This suggests that the new buildings are like the old buildings; and that they, too, will linger.

Another explanation for the persistence of density near streetcars is that the original environment generated agglomerative externalities that continue to hold sway today. These agglomerative externalities should be external benefits that accrue to residents or firms that locate densely. Jane Jacobs' New York neighborhood of shoe sellers, whose extensive selection and diversity attracted many and distant customers, would be one such example of the commercial benefits of agglomeration (Jacobs, 1961). While we were never able to satisfactorily quantify this for Los Angeles, in our estimation, this does seem like a possible channel from the past to the present – and one that works in concert with the zoning hypothesis.

We judge agglomeration as unlikely, however, to be the exclusive mechanism that generates long-run persistence. We know that agglomerative externalities in production of the 1930s are not the agglomerative externalities of today. Michaels et al. (2018) tell us that over time, urban agglomeration has tended more and more toward an "increased emphasis on human interaction." For example, large cities used to be home to the biggest factories. These factories are now in smaller cities; the largest cities now host larger service firms, but without the back office operations which are relegated to cheaper, far flung locations (Duranton and Puga, 2005). It strikes us as unlikely – possible, but unlikely – that the built environment that yielded production externalities in the 1890s also delivers externalities today to a similar extent.

2. What the lingering past means for policy today

But what does the lingering past mean for what we observe today in Bogota and Jakarta – and around the world? To understand, we need still a little more history.

In comparison with Jakarta at the dawn of the twentieth century, Bogota was relatively wealthy, and its initial streetcar system quite extensive. Bogota began running its first streetcars – mule-drawn – in 1884 when it was a city of about 96,000 people (Mejía Pavony, 1999). Fig. 2 shows its compact size and Spanish colonial grid.[9] Although Bogota's population had almost doubled from 1800 to 1880, until the rise of the new transport technology, the city's footprint had remained roughly stagnant. Starting in 1908, streetcar owners shifted rapidly to electric power (Morrison, 2017). At its peak, Bogota had a five-line streetcar system (Morrison, 2017).

As in Los Angeles, transit combined with the relative wealth of Bogota-dwellers expanded the viable envelope of the city, creating a dense downtown and a network of walking neighborhoods connected to that downtown. Developers built these connected neighborhoods to be within walking distance of transit, and within commuting distance of downtown. Also, developers building new areas extended the Spanish colonial grid: a street system that persists today (Mejìa Pavony, 1997, p. 102).

Then, and also like Los Angeles, Bogota turned away from streetcars. When one-quarter of the streetcar fleet was destroyed during the 1947 Bogotazo (a large and violent riot in the wake of the assassination of Jorge Eliecer Gaitàn, the leader of the Liberal Party), Mayor Fernando Mazuera responded by burying the streetcar rails altogether (Tellez, 2018; Morrison, 2017). However, while the streetcars and tracks disappeared, the dense construction they birthed and the grid system they

[8] In the original paper, we go to great lengths to show that this pattern is due to the streetcar, and not to any other influences that pre-date the streetcar. For brevity we omit this discussion here.

[9] Harari (2020) points out the independent value of a compact city on growth.

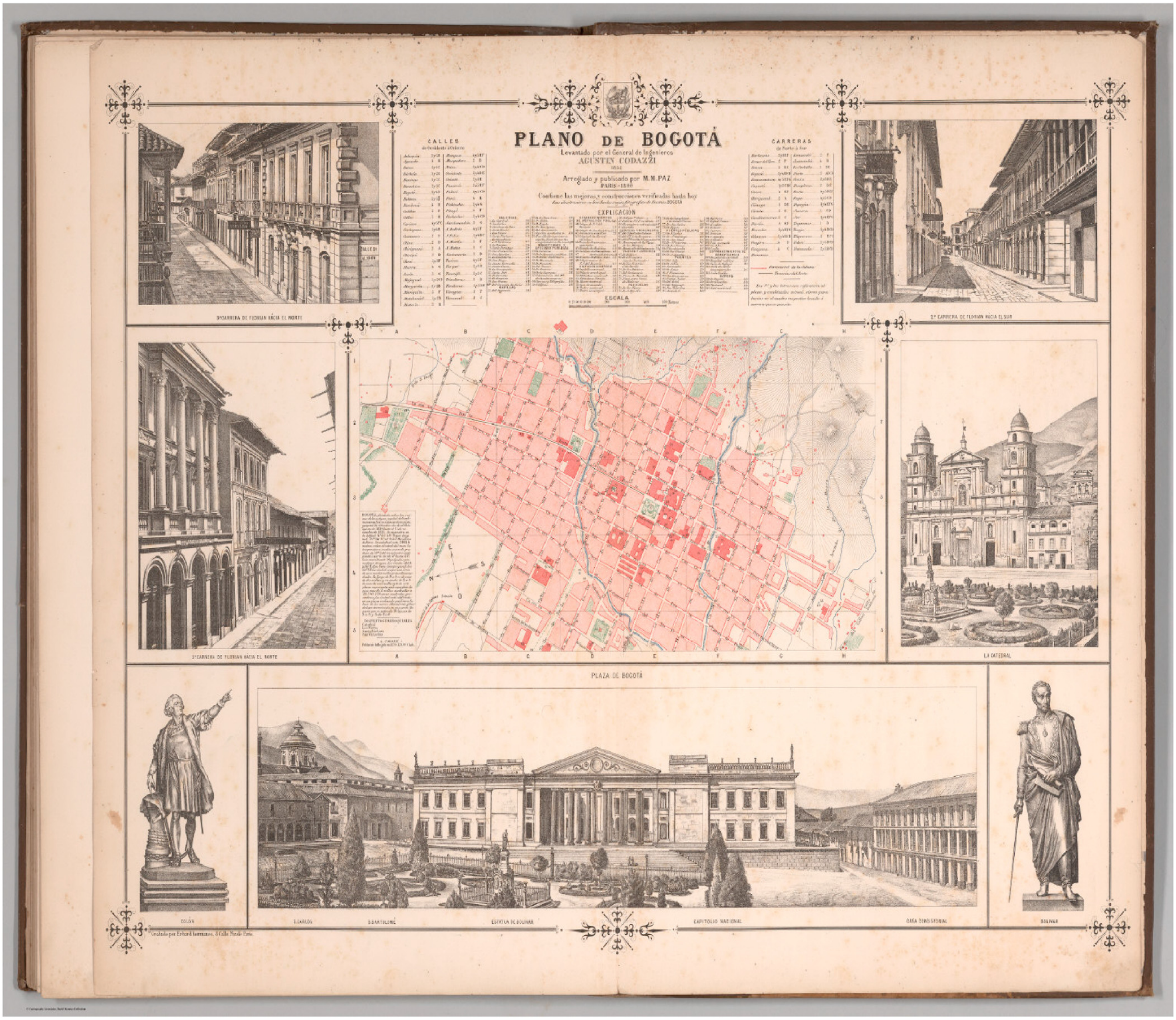


Fig. 2. Bogota, Circa 1890.
Source: Codazzi and Paz (1889).

extended remained.

This legacy of density and gridded streets in Bogota made it easier for public and private actors to provide transit as rural dwellers immigrated over the subsequent decades. While wealthier residents relied on cars, less-wealthy residents primarily used an extensive network of independently operated, uncoordinated buses (Naparstek, 2008). Part of TransMilenio's success likely came from coordinating this existing but disjointed network.

At the dawn of the streetcar era, Jakarta's (then Batavia's) population of approximately 115,000 in 1900 was roughly that of Bogota's. This comparison gives the false impression that the two cities had similar-sized urban areas. Only about 30 percent of Jakarta residents were roughly equivalent in wealth to the 1890 Bogota urban dwellers (Teeuwen, 2007). The remaining roughly 70 percent of the population were mainly quite poor indigenous people, living on the city's edge in informal structures (Teeuwen, 2007). Furthermore, Jakarta was less compact: it was a historically important Dutch trading port and grew at the base of a bay and along a river that fed into the bay. A comparison of a circa 1890 map of Jakarta in Fig. 3 with Bogota's map of roughly the same era in Fig. 2 shows a much smaller, less compact, and less densely designed city.

Jakarta's early transit system was substantially smaller than Bogota's. Already by 1869, Jakarta had a horse-drawn streetcar. In 1881, transit owners replaced horse power with steam. The "system" never extended beyond a single line. Despite this, it, like others, is credited with facilitating a more spread-out urban layout that led to visitors to describe Jakarta as spacious and airy (Silver, 2007, p. 43). Thus, Jakarta's development as an urban hub during the era of dense urban development was substantially less extensive than Bogota's. Furthermore, neither contemporary nor current maps give any evidence that Jakarta was laid on any kind of grid pattern.

Like many systems across the world, Jakarta's tram succumbed to financial difficulties in the 1950s. The system was altogether defunct by 1962 (Teeuwen, 2010).

In the intervening years, post-streetcar but pre-BRT, Jakarta's population grew steadily, but its transit options changed little. Jakarta city officials and urban planners made frequent calls for a comprehensive public transportation network (Silver, 2007). These calls consis-

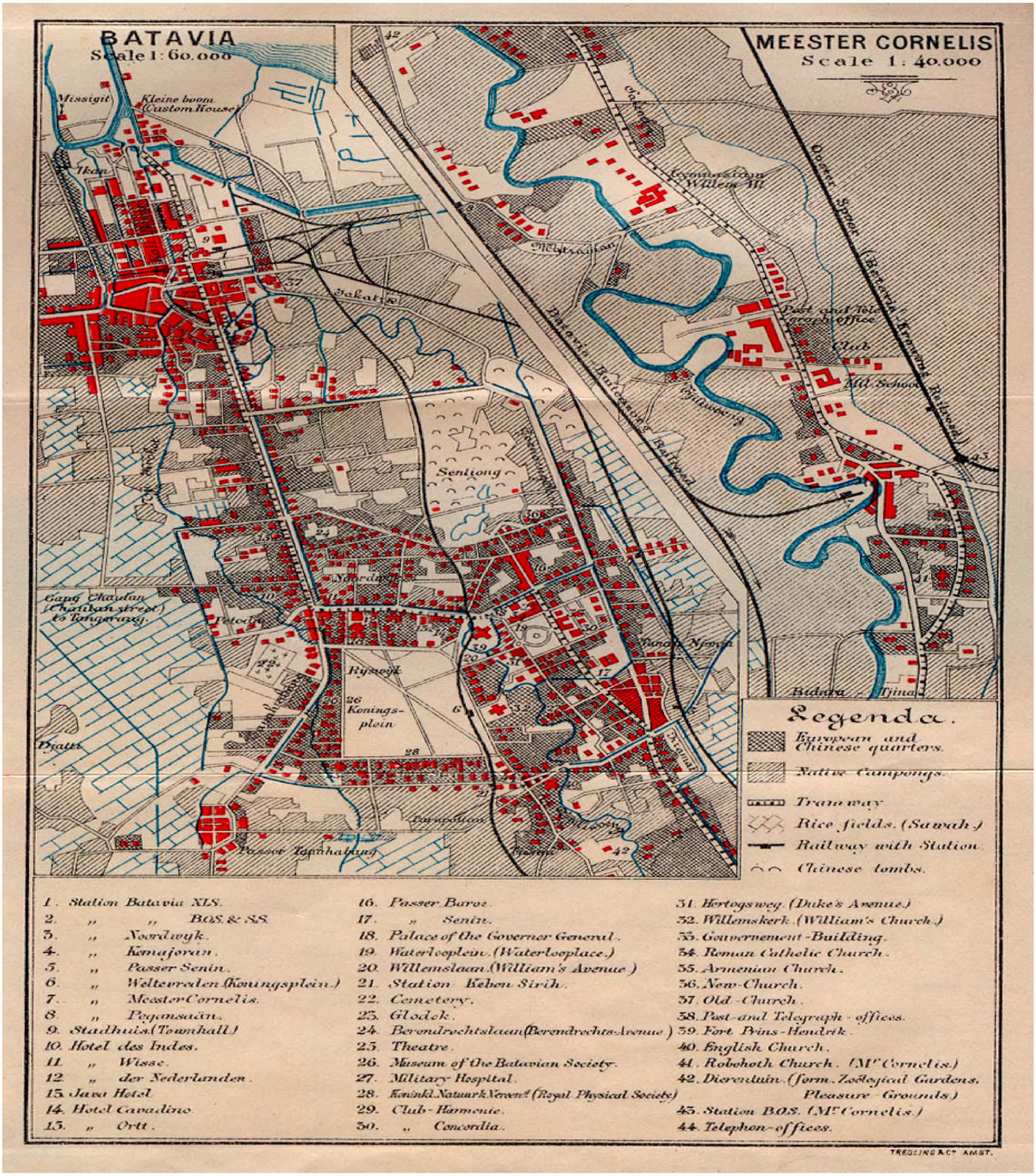
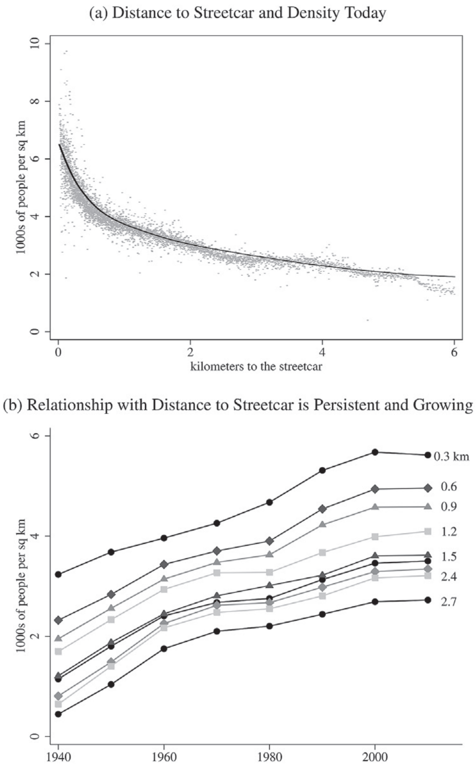


Fig. 3. Jakarta, Circa 1897.
Source: van Bemmelen and Hoover (1897).

tently failed to be met with action, in large part because city planners struggled to identify logistically tractable steps (Silver, 2007). Furthermore, Hook and Replogle (1996) argue that the crony capitalism of the Suharto regime (1967–1998) actively discouraged some forms of public transit provision, for example by banning three-wheeled, non-motorized pedicabs in favor of motorized tuk-tuks. Both these bans and car ownership's role in social status contributed to increased motorization over time (Belgiawan et al., 2016; Susilo and Joeweno, 2017). In sum, more people, more cars, and limited transit improvements yielded the chronic congestion that characterizes Jakarta (Toppa, 2015).

Thus, when planners turned to implement large-scale rapid transit, one of these cities provided much more fertile ground. Urban tran-



Note: This is a reproduction of Figures 1 and 2 from Brooks and Lutz (2019). See original text for details on data and analysis. In brief, subfigure (a) shows a pattern of declining 2010 population density with distance to the streetcar. Each point is the average tract density of approximately 400 parcels. Subfigure (b) shows population density at a given distance from the streetcar (noted at the right) over time (horizontal axis). The figure note for subfigure (b) (Figure 2 in the original source) is incorrect in the originally published version.

Fig. 4. Density and Distance to the Turn-of-the-Twentieth Century Streetcar (Brooks and Lutz, 2019).

sit is most successful when people can walk from home to transit and transit to work. At least some of the physical structure of Bogota was already set up to provide this for transit riders. In contrast, very little of Jakarta's land use was physically "transit-ready." By "transit-ready," we mean land use with sufficient population within a non-onerous walking distance to stops. These conditions are helped by having a grid like Bogota's.

In Bogota and elsewhere, it seems very likely that the gridded street system and transit operate to each other's mutual benefit. A transit stop is more useful the more locations it reaches, and a dense grid may yield more locations to reach. As O'Grady (2014) suggests, a grid system may ease land assembly. Therefore, if transit makes land more valuable, a gridded system may more easily translate potential land value into actual land value. In addition, Akbar et al. (2018, Nov.) credit grids with increasing mobility in India. Gary and O'Grady (2011) argue that the grid system is a physical manifestation of functional institutions and governance.

The past aside, there were certainly differences in BRT implementation that favored Bogota's system over Jakarta's. Tsivanidis (2019) highlights several design features as central to Bogota's success. Bogota's BRT has a separate right of way for most routes, and some of these rights of way have two lanes that allow for passing, accidents and breakdowns. Riders pre-pay at portals before boarding, speeding entry to and exit from buses. A network of free feeder buses improves access for poorer citizens living on the periphery of Bogota. The local government complemented BRT implementation with the addition of bike paths and a limitation on driving based on license plate numbers (Secretaría Jurídica Distrital de la Alcaldía Mayor de Bogotá D.C., 1998). Finally, the government aimed to enhance access by setting BRT fares close to the cost of pre-existing buses.

In contrast, there were notable lapses in the implementation of the Jakarta BRT (Gaduh et al., 2020). Rather than adding supplementary rapid bus lanes and passing lanes, the system largely converted existing traffic lanes to single-use ones. These lanes are frequently clogged with non-BRT vehicles, including motorized scooters. Riders report that the buses themselves are uncomfortable. Many buses only have single front-door entry, further slowing down the less-than-rapid transit. Conflict between BRT operator TransJakarta and the operator and administrator of the rest of Jakarta's transit services hamstrung BRT development by limiting connections to the system (Institute for Transportation and Development Policy, 2017, p. 173, 414–415). Lastly, jurisdictional issues between the capital region government and surrounding municipalities have stymied the activation of planned routes, limiting access in many strategic areas just outside the capital's borders.

While these implementation successes and struggles are surely important, we believe that even these modern details are not independent of long-ago decisions. For example, roads with past streetcars tend to be wider, making it easier for planners to make BRT rights of way, even decades later. Fig. 5 shows a picture of such a road in Bogota, and may suggest why Bogota's system was able to assemble functional rights-of-way. One of Bogota's modern BRT routes follows an original streetcar route; at least one more closely parallels an original streetcar one. In Jakarta, TransJakarta Corridor 1 coincides rather closely with the original 1888 streetcar. Alex Rothenberg writes that "This corridor incidentally seems to be the most well implemented part of the system, was built on a road wider due to the former tram [streetcar] line, and didn't seem to have the negative congestion externalities that the other corridors had."[10] As Rothenberg hints, this success is no accident.

Put differently, while it may have been possible to implement transit poorly in Bogota, it may have been impossible to implement it well in Jakarta – at least at first blush.

To understand what this difference means more broadly, it is interesting to speculate on how many cities are of the transit-friendlier Bogota type, and how many are of the less-amenable Jakarta type. One key feature is the extent of city growth before auto hegemony. The larger the city in the pre-auto era, the more Bogota-like it should be. But other factors are surely at play: the extent of subsequent growth of population, the share of land in auto-centric use, the extent and quality of the grid system, the location of a city in the trading network, the quality and type of institutions, with an emphasis on those related to land use. Idiosyncratic city-specific features are also at play. For example, the strict limits posed by Manhattan's island status undoubtedly play a role in that borough's unusual density.

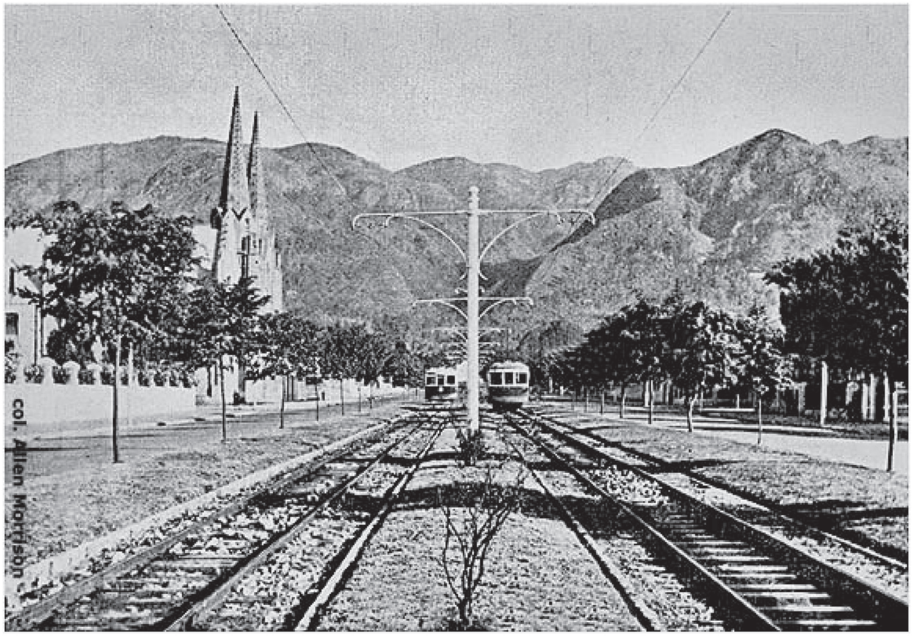
3. So what can we do?

In the 1989 movie *Field of Dreams*, Kevin Costner's washed-up baseball player hears voices telling him to build a baseball diamond in the middle of a cornfield: "Build it, and they will come." Despite Costner's family's doubts about his sanity, he builds the diamond and "they" do come to his field and play, as do crowds and as does the eventual redemption of Costner's character.

Will "they" ever come to mass transit put into areas built without the density that characterizes streetcar neighborhoods? In the case of Bogota, we have highlighted the relative success of modern transit in areas where original transit existed and have attributed at least part of this success to the underlying land use. But this brings up a concerning converse: Can transit ever be successful where it did not exist in the past, or existed to a very limited degree, as in Jakarta?

If the implementation of successful transit is limited to areas developed 100 or more years ago, transit holds much less promise for generating urban areas that provide the benefits of density, including agglomeration externalities and environmental gains. Thus, we view the ability

[10] Email correspondence with Alex Rothenberg, August 11, 2020.



Note: A picture postcard image of Bogota in the 1930s.

Fig. 5. A Wide Road Hosting a Bogota Streetcar, c. 1930.
Source: http://www.tramz.com/co/bg/t/ts.html.

of transit to succeed in places built in the post-streetcar era as both as an open question and as a major policy issue going forward.

We suggest three key conditions under which transit retrofitting could successfully occur. This is not a mix-and-match list – transit needs all three conditions to hold to stand a fighting chance. These conditions are that (i) the mass transit option must exceed the speed of the private car; (ii) mass transit must serve sufficiently dense areas; and (iii) mass transit must take people where they want to go.

First, to be successful, transit needs to at least sometimes exceed the speed of the car, in part because the transit experience is virtually never preferable to riding in a private car. Transit can be "fast" because it is has well-routed rights-of-way and regular service. It can also be "fast" because traffic is so terrible that even a mediocre right-of-way is an improvement. Importantly, transit must exceed the speed of the private car.

Second, transit also needs to serve dense areas to make its fixed investment worthwhile. This is hardly a new insight, and was foremost in mind for those concerned with transit's unraveling in the 1950s and '60s (Schnore, 1968; Yago, 1984, p. 12). In areas built during the hegemonic rule of the car – and therefore not built to a density that encourages walking – transit success almost always calls for densification of previous development. Densification of existing development is frequently politically excruciating. In Los Angeles, and other developed world cities, zoning explicitly limits the amount of allowable densification, and political realities impose further restrictions. As a political matter, densification seems easiest in areas that had industrial, rather than residential, initial uses (Hamilton, 2020a). In the developing world, even if zoning is non-existent or irregularly enforced, important political limitations on redevelopment remain (Henderson et al., 2020).

And third, transit must take people somewhere they want to go. Successful transit connects residential locations and work locations for a sufficiently large number of residents. Transit also becomes more appealing if parking is expensive, difficult, or insecure at one or both endpoints. Generally, transit succeeds when it mirrors flows desired by residents.

While we believe these three conditions are the *sine qua non* for success, there are surely other important determinants of transit success. In large metropolitan areas, it seems likely that institutional structures that either put all decision-making in one jurisdiction, or compel participation by all affected jurisdictions, should be more likely to succeed. In addition, the topography and history of some jurisdictions may better support other alternatives to transit, such as bikes and motorbikes.

Is it possible for areas built after the 1910s to satisfy the three criteria that we identify as key? In other words, can you build a successful transit system to the vast swath of Jakarta built after 1910, or other places of its ilk? We are now at the beginning of this great experiment of transit retrofitting, not just in Jakarta, but around the world. Because land-use patterns change so slowly, our gratification will surely be slower than Kevin Costner's via the baseball field. Severen (2020) gives us some preliminary evidence on the impact of the re-adoption of transit in Los Angeles, arguing that while the new service increased commuting between affected areas, the welfare gain from transit has not yet exceeded the cost.

At least one US example bears watching. The Washington exurb of Tysons Corner was little more than a gas station in 1950. It is now the Washington region's employment hub, the home of seven Fortune 500 companies, and nexus of much of the military-industrial complex (Moran, 2019; Clabaugh, 2020). It was built entirely in the auto era, and its land use and density reflect that: large blocks, multi-lane streets, big parking lots and an absence of pedestrian infrastructure and scale (Garreau, 1991).

There is now a concerted effort to retrofit Tysons to take advantage of the 2014 extension of the Washington rail transit system that includes four stops in Tysons proper. This extension connects Tysons both to downtown, to further exurbs that host large portions US's cloud computing, and to Dulles airport, the largest of the region's three airports.[11] To retrofit, the Fairfax County government, in which Tysons sits, made substantive changes to zoning that increased the number of units allowed per lot. The area has a goal of roughly 50,000 housing units by 2050. To date, there have been about 12,000 built and 30,000

[11] An additional extension of this "Silver line" that includes Dulles airport is scheduled to open in early 2021.

approved but unbuilt. The county has also encouraged large developments that can re-draw the street grid to more pedestrian friendly sizes. Tysons has had more success in providing housing than in pedestrianizing infrastructure. The transition of the area remains very much a work in progress (Hamilton, 2020a,b).

Interestingly, less developed countries may have more success than developed ones in extending formal transit to areas developed largely in its absence. The relative poverty of less developed countries – yielding fewer inhabitants with private cars – made dense construction more likely even after the rise of the automobile. This continued dense development facilitated viable (if not always particularly safe) transit systems operated by private firms (Mehndiratta and Rodriguez, 2017). With the exception of wealthy neighborhoods where land use patterns were driven by car ownership, most developing country post-streetcar era neighborhoods were built at more transit-friendly densities.

This dense construction, combined with growth in motor vehicle ownership and usage that are outpacing population, yields high congestion in the developing world (Motta et al., 2013). While congestion produces pollution, resentment, and ill-health, it makes the relative speediness of alternative forms of transit much more appealing. And this increase in relative speed is surely an opportunity for transit.

So in the arena of land use and transit, can the past ever really be past? Ultimately, only time will tell whether new transit is powerful enough to carve new land use into urban areas originally defined by the automobile. But take heart: no less a figure than philosopher Jean-Paul Sartre rejected Faulkner's emphasis on the past as unduly restrictive. Sartre argued that Faulkner confuses “chronology with temporality” (Skirry, 2001, p. 22). In other words, the past sometimes really is just past, and predicate is not determinate. We wait to see.

Author statement

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Declaration of competing interest

Authors declare that they have no conflicts of interest.

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