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September 15, 2026

Dear Ms. Breza, dear Mr. Vivian and Mr. Chandasekhar,

I am writing to apply to the Workshop on Development Economics and Networks for Early-Career Researchers, to be held on December 5, 2026, in Cambridge, Massachusetts. I am a 3rd-year PhD candidate in Economics at Goethe University Frankfurt. The recommendation letter can be provided by my first supervisor

- Name: Prof. Matthias Schündeln, Ph.D.
- Email: schuendeln@wiwi.uni-frankfurt.de

Enclosed with this letter are my curriculum vitae, a brief statement of my motivation for attending, and my working paper, titled "Tracks to Growth? The Local Economic Effects of New Standard Gauge Railways in Sub-Saharan Africa".

Thank you very much for considering my application. I would welcome the opportunity to participate in this workshop and to discuss my work with the other participants.

Sincerely,

Ellen Bielfeldt

ELLEN CIARA BIELFELDT

Hardenbergstraße 18
60327 Frankfurt am Main, Germany
Nationality: German, Irish

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EDUCATION

Ph.D., Economics Track
GSEFM at Goethe University Frankfurt
Advisor: Prof. Matthias Schündeln, Ph.D. 2023-2028

M.Sc., International Economics and Economic Policy
Goethe University Frankfurt 10.2022-03.2023
Grade Average: 1.3 (not completed)

B.Sc., Business Administration and Economics
Goethe University Frankfurt 2019-2022
Final Grade: 1.1
Thesis: The Impact of the 2020 Temporary VAT-Reduction on Consumption

FIELDS OF INTEREST

Development Economics, especially Political Economy, Economic History, Institutional Economics and Transport Economics

ONGOING RESEARCH PROJECTS

Tracks to Growth? The Local Economic Effects of New Standard Gauge Railways in Sub-Saharan Africa

The Impact of the Green Revolution on Child Labour in India
Joint work with Prof. Matthias Schündeln, Ph.D. and Dominik Naeher, Ph.D.

The Long-Term Consequences of Forced Removals in Apartheid South Africa

TEACHING

Development Economics 2 (M.Sc. level) 2026
TA for Prof. Matthias Schündeln, Ph.D.

Introduction to Finance (B.Sc. level) 2021
TA for Prof. Dr. Maik Schmeling

Preliminary Maths (B.Sc. level) 2021-2022
TA for Prof. Simone Wies, Ph.D.

EMPLOYMENT

Working Student at KfW IPEX-Bank GmbH, Frankfurt, Germany 2022-2023
Department: Land-based transportation

Administrative Assistant at Arbeiter-Samariter-Bund, Hattersheim, Germany 2021

Voluntary Social Service Year at Abalimi Bezekhaya, Cape Town, South Africa 2017-2018

AWARDS & SCHOLARSHIPS

PhD scholarship awarded by the Chair of Macroeconomics and Development 2023-2024

Member of the Master Dean's List (Students with grade "very good") 2023

Recipient of the Deutschlandstipendium 2020, 2023

Member of the Bachelor Dean's List (Top 5% of students) 2019-2022

Erasmus Grant 2020

CURRENT AND COMPLETED PH.D. COURSES

Course	Lecturer	Credits	Grade
Mathematical Methods	Prof. Kaas	8	2.3
Advanced Econometrics 1	Prof. Gutknecht, Prof. Schank	8	1.3
Advanced Econometrics 2	Prof. Hassler, Prof. Binder	8	2.3
Programming Languages	Dr. Brancatelli, Dr. Fritzsche	4	1.7
Advanced Microeconomics 1	Prof. Weichenrieder, Prof. Blonski	8	1.0
Advanced Microeconomics 2	Prof. Inderst, Prof. Walz	8	1.0
Advanced Macroeconomics 1	Prof. Fuchs-Schündeln, Prof. Meyer-Gohde	8	1.3
Advanced Macroeconomics 2	Prof. Trabandt, Prof. Faia	8	1.3
Applied Econometrics: Health Economics	Prof. van Ewijk	6	1.0
Intergenerational Economics	Prof. Schunk	6	1.0
Textual Analysis in Finance	Prof. Hillert	6	1.7
Development Microeconomics	Prof. Schündeln	6	1.3
Macroeconomics with Micro Data	Prof. Dürnecker	6	1.0
Theoretical and Empirical Organizational Economics	Prof. Friebel	6	1.0
BREAD-IGC Course on Political Economy (ongoing)	various	NA	NA

Motivation

My interest in development economics, and particularly in the long-run consequences of historical institutions, began before I started my undergraduate studies. During a year of German voluntary social service in Cape Town, South Africa, I worked with an organization that supported small-scale and subsistence farmers by providing resources such as seeds and workshops on sustainable agricultural practices. Because this project was based in the Cape Flats, most of the farmers I worked with were Xhosa. Hearing firsthand how their lives had been shaped by Apartheid was what first drew me to study its long-term economic effects, and this experience continues to motivate my research today.

I am now a third-year PhD candidate at Goethe University Frankfurt (the first two years of the program consist of coursework), and since my second year I have been working at the Chair of Development Economics of Prof. Schündeln, Ph.D. My current working paper examines the effects of railway infrastructure in Sub-Saharan Africa, a topic I see as both historically important and highly relevant to ongoing policy debates on transport and market access. Beyond this line of work in transport economics, I am also interested in historical and institutional economics more broadly, both of which connect to my ongoing research on the forced displacement of communities during Apartheid. I am additionally interested in the economics of child labor and its connection to agriculture.

I am applying to this workshop because I want to present my work and, more importantly, connect with other researchers in the field. As I am still at an early stage of my dissertation, feedback from both senior researchers and fellow PhD students would be extremely valuable in shaping the direction of my work. I am eager to build a network that could lead to future collaborations and coauthorships. The Chair of Development Economics at Frankfurt is small, so establishing additional contacts within the development economics community would be particularly helpful for me. I have taken every development-related course offered at Frankfurt, but I am eager to keep learning, which is also why currently attend the BREAD-ICG course on development economics and why I hope to have the opportunity to attend this workshop as well. Finally, I see this workshop as a valuable opportunity to gain experience presenting my work in front of an audience of both senior and early-career researchers, which I expect will strengthen both my paper and my ability to communicate my research going forward.

Tracks to Growth? The Local Economic Effects of New Standard Gauge Railways in Sub-Saharan Africa

Ellen C. Bielfeldt[1]

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Abstract

Since 2016, five Sub-Saharan African countries (Djibouti, Ethiopia, Kenya, Nigeria, and Tanzania) have opened new Standard Gauge Railway lines at considerable cost, with the stated aim of improving regional connectivity and market access. This paper estimates the local economic effects of these lines using a staggered difference-in-differences design, restricting the sample to inconsequential intermediate places to address the endogenous placement of railway lines. As direct measures of local economic development are unavailable at the required granularity, four remotely-sensed outcomes are used as proxies: nighttime lights, population, built-up surface, and PM2.5 pollution. At the segment level, nighttime lights increase significantly for three of the eight analysed segments (Mombasa - Nairobi in Kenya and both Tanzanian segments) while pollution rises significantly only along the diesel-powered Nairobi - Naivasha segment. Population and built-up surface show no significant changes for any segment. At the corridor level, only the Kenyan nighttime-lights effect survives aggregation. Results are robust to alternative handling of the construction period and to conditioning on baseline outcome levels and colonial-era railway proximity, though the latter also shows that estimates are not as well identified for the segments where treated and control cells are most alike at baseline. These findings suggest that, so far, the new SGR lines have had limited and heterogeneous local economic effects, raising questions about the returns to these large infrastructure investments.

1 Introduction

Since 2016, Kenya, Tanzania, Ethiopia and Nigeria have made large investments into their transport systems, constructing new Standard Gauge Railway (SGR) lines. Each spans hundreds of kilometres, connects multiple regions and cities for passenger and freight, and is often constructed by Chinese state-operated firms. International banking consortia help finance these large projects, as they come at considerable costs. Kenya, for example, has invested over $4 billion, close to 3% of national GDP, for two segments of SGR lines, which measure over 600 kilometres, raising the cost-benefit question. These projects come at a time when the vast majority of transport in Sub-Saharan Africa (SSA) is road-based, leading to one of the highest levels of trading costs globally. Hence, these additional transport corridors may enable better market access, in line with the proclaimed goals of improving interregional connectivity and transnational trade. In light of this, more segments within these five countries are being planned, while additional countries, such as Rwanda, Burundi and the Democratic Republic of the Congo, have announced that they want to join this new SGR network.

In developed countries, railway projects have been found to have largely positive impacts on the local economies along the lines, caused by in-migration of people more likely to use transit, increased home values near stations, and compositional changes of the local industries (see Ahlfeldt and Feddersen (2018) for Germany and Baum-Snow (2007) for the USA). In developing countries, the evidence from infrastructure projects stems mostly from road-construction projects or colonial railway systems. A large-scale road building project in China led to reductions in GDP growth of peripheral counties who were not targeted by this policy (Faber (2014)), and increased levels of GDP for areas close to the new network (Banerjee et al. (2020)). In India, studies have shown that rural roads led to a labour reallocation out of agriculture, but no gains in income, assets or production (Asher and Novosad (2020)). Evidence from the same mode of transport, but a different time, stems from colonial railways. They have been found to have persistent effects until today, through sunk investments and colonial urbanization (Jedwab et al. (2015), Jedwab and Moradi (2016), Donaldson (2018)). As these findings either stem from a different mode of transport or a different time, these findings may not be directly transferable to contemporary railway projects in SSA. While roads provide continuous access (possible to join nearly anywhere), railway systems only provide nodal access at the train stations. Additionally, the last-mile (e.g., house to station, or station to market) cannot usually be made by train, unlike roads. Furthermore, colonial railways were built with the aim of extracting labour and capital, and most studies focus on path dependence.

Therefore, this paper looks at the impact of the new SGR lines in SSA on local economic development.

The new SGR lines in SSA have been built with the aim of improving connectivity between regions and enhancing market access, among other goals. While some countries there have railways, most were built during colonial times and are in bad condition or not used, often due to mismanagement. This contributes to the lack of transport corridors and most of the interregional transport, of people and freight, being road-based in SSA. Consequently, this region has one of the highest levels of trading costs globally. Against this, the new SGR lines have been constructed and

are in operation in Kenya, Tanzania, Nigeria, Ethiopia and Djibouti, and additional countries are already planning on joining and extending these SGR projects, despite the high construction costs.

To estimate the impact of the new SGR lines, this paper focuses on local economic development outcomes, such as GDP and market access, in the five SSA countries. As these are not directly available at the frequencies necessary for the analysis, the analysis relies on remotely sensed outcomes. Nighttime lights and population estimates have been shown to be adequate proxies for local economic development and are used at a monthly or annual frequency here. They are complemented by data for built-up surfaces and pollution.

In this setup, two main problems arise when trying to estimate the impact of the SGR lines on local economic development, calling for careful estimation approaches. The first problem is that the new SGR lines were most likely not randomly placed within the five SSA-countries. Hence, the inconsequential places approach proposed by Chandra and Thompson (2000) and Alder (2025) is used, which restricts the sample to only consist of intermediate cities that were connected to the line accidentally. The second problem is connected to the colonial railways, which in some places lie close to new SGR lines and have been shown to have persistent impacts on the local economy until today. Thus, this paper uses a Difference-in-Differences approach, controlling for these cell-level characteristics, to account for baseline differences.

The estimates show that for three out of the eight analysed segments, nighttime lights increase at the segment level, while at the corridor level only the Kenyan SGR leads to increases in nighttime lights. Pollution increases for the Nairobi - Naivasha segment. These proxies hint at an increased level of local economic development in the treated cells, while other measures, such as built-up surfaces and population, are estimated not to change, though these effects may not be visible yet.

This analysis contributes to different strands of the literature. First, this is one of the very few papers that provides systematic evidence on the local economic effects of the currently constructed SGR projects in SSA. The related literatures on railway projects in developed countries, road-projects in developing countries, as well as from colonial railways there, do not necessarily transfer to this context. Second, the inconsequential places approach is adapted from roads to the case of railways, making a methodological contribution. Lastly, as four different outcome variables are used instead of just the common nighttime lights, it is possible to analyse the effects of the new railways in a more nuanced way.

The remaining part of this paper is structured as follows: Chapter 2 reviews the relevant literature on infrastructure and railway projects, contemporary and historical. Chapter 3 then describes the current state and the history of railway infrastructure in SSA, followed by a conceptual framework in Chapter 4 and a description of the data sets used in Chapter 5. The empirical strategy is outlined in Chapter 6; Chapter 7 presents the main results and robustness checks, which are then discussed in Chapter 8. Finally, Chapter 9 concludes the paper.

2 Literature

This paper connects to the literature on railways in developed countries, which provides evidence on a positive impact of railway projects on local economic development. The literature on developing countries, which uses mostly roads as large-scale land-based infrastructure projects, yields mixed results, depending on whether a place was targeted by the project or not. The colonial railways literature that this paper connects to suggests that these have persisting effects until today, through path dependence and colonial urbanization.

2.1 Evidence from Developed Countries

The literature on railways in developed countries finds mostly positive impacts of such projects. Studying the construction of a new High-Speed railway line in Germany, Ahlfeldt and Feddersen (2018) find that the GDP of the three counties which lie on the new line and have a station serving it increased by 8.5%. They attribute this to improved market access and agglomeration effects. They estimate that the spillover effects, from areas directly along the line to more peripheral areas, decrease with travel time and vanish when it exceeds 200 minutes. For the USA, Baum-Snow and Kahn (2000) find that new rail transit projects led to an increase in housing values along the lines, attracting migrants to those areas. Additionally, more people chose public transit as a mode of transport than before.

2.2 Evidence from Developing Countries

Most evidence on the impact of infrastructure projects in developing countries stems from roads, with mixed results. Tan et al. (2023a) find that the highway system in China led to reduced GDP growth in those areas which were not targeted by the new roads. Those peripheral counties experienced a decline in industrial output growth, leading to negative effects on the local GDP growth. Relatedly, Banerjee et al. (2020) also look at transportation networks in China. They estimate that GDP per capita increases with proximity to such networks, across different sectors, while the growth of GDP is unchanged. A decentralization was found by Baum-Snow et al. (2017), depending on the type of radial transport. Whereas highways were found to lead to a decentralization of the service sector in China, railways led to a dispersion of the industrial sector. For rural roads in India, Asher and Novosad (2020) estimate that they do not alter the economies of villages they connect to. While they seem to increase the transport possibilities, agricultural workers did not move out of agriculture or produced and earned more.

For evidence on railways in those countries, the evidence arises from a different time period. During the colonial times the last wave of major railway projects occurred, for which the literature points to persistent effects. Jedwab et al. (2015) find that for Kenya, the colonial railways defined where major cities were located at independence, including the areas of European settlers and Asian traders. Additionally, when those departed after Kenya gained independence in 1963, taking physical and human capital with them, those cities remained, showing persisting effects of those railway lines. Looking at Ghana, Jedwab and Moradi (2016) find that along the colonial railway line

populations increased. In rural areas they increased as the cocoa production demanded more labour, whereas in urban areas an increase in trade led to them being more populated. Similarly, Donaldson (2018) models that additional transport corridors, resulting from the colonial railway in India, led to a decrease in trade costs and hence increased trade and, as a result, also income levels.

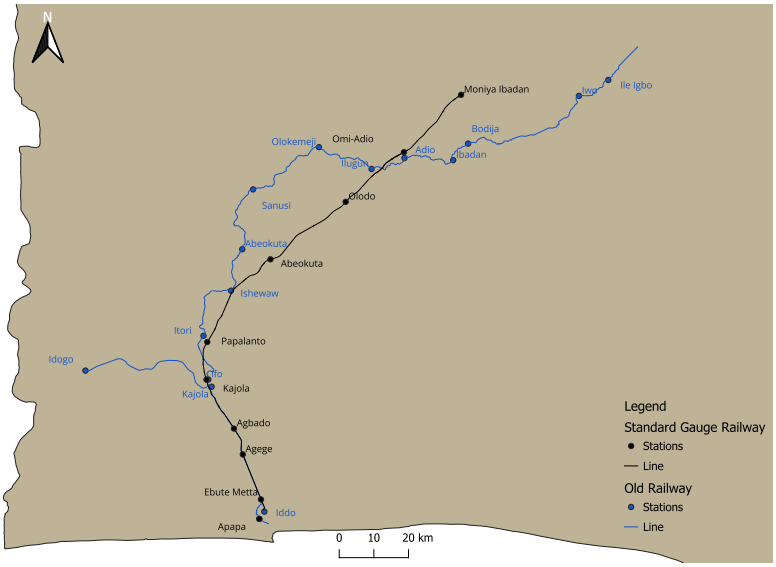
3 Railway Infrastructure in SSA

While some SSA countries have existing railway lines from colonial times, these are deteriorating. Hence, the vast majority of transport relies on roads. To improve connectivity and reduce transport costs, large-scale railway projects have been implemented in five SSA countries, with more countries planning on joining.

3.1 Historical Railways

During colonial times, many sub-Saharan African countries had railway lines, including the five countries analysed here. Figure 1, for example, shows one of the old lines in Nigeria, connecting the coastal town of Lagos with the inland areas around Iwo. Similarly, Kenya had an east-west railway line, running from the coastal town of Mombasa right to the border with Uganda, the so-called Uganda Railway. It was built with the objective of getting access to the Nile, originating in Uganda, as this was deemed an important trade route in the "Scramble for Africa" (Jedwab et al. 2015).

Fig. 1: Colonial and SGR Lines in South-West Nigeria



Source: OpenStreetMap (2026d), United States Defense Mapping Agency (1992) and author's illustration.

Besides connecting coastal regions to those further inland and securing access over important trade routes, resource control and extraction played an important role in the construction of such railway lines. In Ghana, the railway lines were built to connect coastal areas with the mining regions as well as the hinterland. These additional transport corridors led to a reduction in trade cost, making it profitable to cultivate cocoa, of which Ghana hence became one of the largest global exporters (Jedwab and Moradi 2016). Additionally, they were built for military domination (Jedwab et al. 2017) in the colonies. However, after these countries achieved independence from the colonial powers, much of the existing railway systems declined due to mismanagement and a lack of investments (Jedwab et al. 2017).

3.2 Current Means of Transport

Currently, transport of people and freight, especially interregional, is road-based in SSA. While some countries have railways from colonial times, these have been deteriorating due to mismanagement and little investments. As seen in table 1, the fraction of kilometres that passengers travelled by rail, compared to road, is negligible. Salon and Gulyani (2019) estimate that for adults in urban Kenyan areas 89% of commuting is done by either walking or using the road-based matatus. For freight, the fractions are larger, especially for Djibouti, where more freight is transported by rail than by road[1]. Nevertheless, especially for Ethiopia, the road is still the dominant mode of transport. This contributes to the lack of transport corridors, raising the cost of trade in Africa to one of the highest globally. Atkin and Donaldson (2015) estimate that, compared to the United States, the effect of log distance on costs for trade is up to five times as large for Ethiopia and Nigeria. Similarly, Porteous (2019) finds that the median trade costs are five times higher for all SSA countries compared to the rest of the world.

Table 1: Comparison of Modes of Transport in 2018

	Passenger [mio km]			Freight [mio tonnes-km]		
	Rail	Road	Rail / Road	Rail	Road	Rail / Road
Djibouti[1]	15	1297	1%	3791	2302	165%
Ethiopia	398	33970	1%	789	27235	3%
Kenya	47	52485	0%	5506	8855	62%
Nigeria	191	217954	0%	12156	73112	17%
Tanzania	0.05	62552	0%	3095	12094	26%

Sources: Tan et al. (2023a), Tan et al. (2023b), Tan et al. (2023c), Tan et al. (2023d), Tan et al. (2023e)

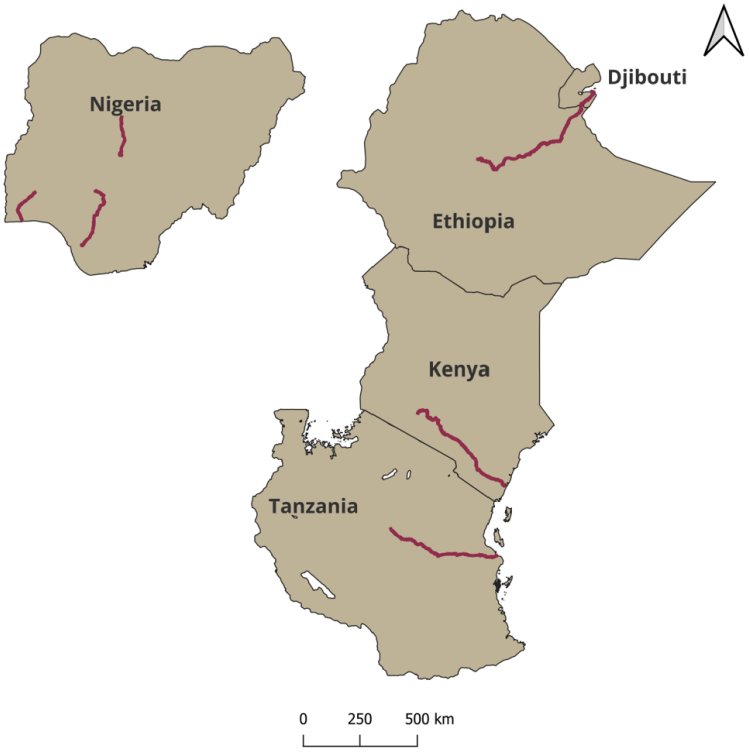
[1]Estimated data for 2019

[1]Numbers for Djibouti are estimated for 2019, see Tan et al. (2023a).

3.3 Description of SGR Projects

Since 2016, five countries in SSA (Djibouti, Ethiopia, Kenya, Nigeria, and Tanzania) have opened up SGR lines (see Figure 2 and Table 2). They were constructed with the aim of improving the connectivity between regions, reducing the transport and trade costs, and improving market access for communities along the new lines. Landlocked countries, such as Ethiopia, should benefit from access to ports via the new Addis Ababa - Djibouti line (African Union - Programme for Infrastructure Development in Africa 2026). The segments vary in length (120-756 km), were mostly built by Chinese state-operated firms and financed through Chinese loans or international banking consortiums, as they come at considerable costs. Additional segments are already being planned within these five countries, but also new ones, such as Uganda, Rwanda and Burundi. Many of the newly constructed lines follow the old, mostly defunct colonial lines closely, such as the Lagos - Ibadan SGR line in Nigeria (see Figure 1)

Fig. 2: Location of Operational SGR Lines



Source: OpenStreetMap (2026a), OpenStreetMap (2026b), OpenStreetMap (2026c), OpenStreetMap (2026d), OpenStreetMap (2026e) and author's illustration.

Table 2: Overview of Constructed SGR Lines

Segment	Length	Cost	Power	Construction Start	Opening Date
Panel A: *Djibouti*					
Addis Ababa - Djibouti	100 km	$505 mio	Electric	02.2012	01.01.2018
Panel B: *Ethiopia*					
Addis Ababa - Djibouti	656 km	$3.4 bn	Electric	10.2011	01.01.2018
Panel C: *Kenya*					
Mombasa - Nairobi	472 km	$3.8 bn	Diesel	12.12.2014	31.05.2017
Nairobi - Naivasha	120 km	$1.5 bn	Diesel	19.10.2016	16.10.2019
Panel D: *Nigeria*					
Warri - Itakpe	326 km	$200 mio[1]	Diesel	11.2009	15.10.2020
Abuja - Kaduna	187 km	$874 mio	Diesel	20.02.2011	26.07.2016
Lagos - Ibadan	156 km	$1.5 bn	Diesel	03.2017	15.06.2021
Panel E: *Tanzania*					
Dar es Salaam - Morogoro	202 km	$1.2 bn	Electric	01.04.2017	14.06.2024
Morogoro - Makutupora	258 km	$1.46 bn	Electric	14.03.2018	25.07.2024

[1] For revival and completion. Construction originally started in 1987, then abandoned after 254km were built.

4 Conceptual Framework

The main mechanism through which the new SGR lines are expected to affect local development is market access. The new lines can lower transport and trade costs for treated cells: it provides an additional mode for labourers to commute to work (for stations serving passengers) and for firms to ship their produced output (for stations serving freight), raising market access (Donaldson (2018), Faber (2014), Ahlfeldt and Feddersen (2018)). This in turn makes these areas more attractive for investments and migration. Thus, it is expected that the new railway lines lead to increased local economic activity, raising nighttime lights levels, as well as population and built-up surfaces for treated cells, relative to untreated ones. As population and built-up surfaces changes depend on migration choices and construction work, impacts for such factors possibly will only become visible after some time periods have passed. Meanwhile, pollution levels and nighttime lights are expected to adjust more rapidly to changes in the levels of local economic activity.

Railways only provide access at the stations, and not anywhere in between, as it is the case for roads. Thus, it is expected that the effects of the opening of the new railway lines are also concentrated in these areas. Furthermore, if the railway leads to additional welfare through agglomeration effects building up over time (Ahlfeldt and Feddersen 2018), or if they only reallocate resources and gains from more peripheral areas to the treated areas (Faber 2014), remains an open question beyond the scope of the current estimation design.

An ambiguity for expected results also holds for pollution. As seen in Table 2, some lines are powered by electricity, others use diesel-powered trains, creating local emissions. Combined with road-based last-mile transport, which is commonly fossil-fuel powered, this leads to increased levels of pollution in areas that the new trains pass

through. This may be further elevated through the expected increase in local economic activity in the areas that have an SGR station close by. However, when the lines are powered by (locally) emission-free modes, such as electricity, and the new transport corridors lead to a modal shift towards rail and away from road-based passenger and freight transport, this may lead to a decrease in pollution levels.

Overall, three testable hypotheses emerge (all relative to untreated cells):

- H1: Nighttime lights increase for treated cells
- H2: Population and built-up area increase for treated cells, with a lag
- H3: Pollution effects are more likely to be positive for diesel-powered segments and more likely to be negative or null for electric segments

5 Data

The analysis focuses on local economic development outcomes, such as GDP and market access. As these are not measured at the granularity needed in the analysed countries, or too infrequently, this paper uses remotely sensed data, such as nighttime lights and building data, as proxies for local economic development.

5.1 Data on Railway Lines

For each of the five countries, the routes and stations of the new SGR lines are gathered from OpenStreetMap (2026a-e) and confirmed via Google Earth images. Around these lines, a 50km buffer zone is drawn, divided into 2km by 2km grid cells, for which the outcome variables are downloaded. The construction dates are found through a search of webpages of operators, construction firms, and newspapers articles. The same applies to the opening dates for each segment. For the main analysis, stations of all types are included, regardless of whether they serve only passengers or freight or if they serve both. Stations for which it is unclear if they are in use, as in they are visible on satellite images but do not appear on operator pages, are dropped from the main analysis sample.

The routes of the old colonial railways were collected from the Digital Chart of the World United States Defense Mapping Agency (1992), which provides the railway lines of the year 1992, hence before any of the new SGR lines were built. The stations were then found via web search and confirmed, where possible, with Google Earth images.

5.2 Outcome Variables

To measure local economic development, proxies such as nighttime lights, population estimates, and building infrastructure are used, all remotely sensed. They are all downloaded for the same 2km by 2km grid cells that were created for each 50km buffer zone around the SGR segments.

Nighttime lights have been shown to be a good proxy for local economic growth (see Henderson et al. (2012)), hence they will be used to measure local economic activity along the new railway lines. For the time period of April 2012 to December 2025, data from the Visible Infrared Imaging Radiometer Suite (VIIRS) is used (Earth Observation Group 2026). The images are available at a monthly frequency for 463.83m

pixels and deliver mean radiances, which are then transformed using asinh to deal with very large values as well as negative values. As some segments of the new SGR lines were constructed before 2012, additional nighttime lights data is collected from the Consistent and Corrected Nighttime Light dataset by Zhao et al. (2020) for the periods before 2012. It is available at an annual frequency for 1000m pixels.

To analyse whether people moved closer to the new SGR lines, data on the population of each grid cell is collected from the LandScan data set (Sims et al. 2023). It provides estimates of the headcounts for 1000m pixels, at an annual frequency up until 2024. Data on the distribution of built-up surfaces, total and non-residential, is used to examine if these infrastructure projects led to an increased urbanization. Pesaresi and Politis (2023) provide this for 100m pixels at a 5-year frequency, ending in 2025. Additionally, it will be analysed if these new transport corridors, some of which are electrically-powered, led to a change in the pollution exposure in the grid cells. For this, data from Shen et al. (2024) is used. It provides the monthly estimates of ground-level fine particular matter, PM2.5, for 0.01° pixels, up until 2022.

5.3 Summary Statistics

Table 3 gives an overview of the main variables, measured before construction of each segment started. It shows that the placement of these new SGR lines is not random, but rather follows a certain pattern: treated cells (those with or close to a station, see exact definition below in Chapter 6) are, on average, brighter, more populated, have more built-up surfaces, and are more polluted[2] (Exception: in Nigeria and Tanzania, treated cells are slightly less polluted). It confirms that the new railway lines were especially built in urban areas where many possible passengers are located.

By definition, treated cells are closer to the new SGR lines and stations than control cells. Additionally, they are also closer to the old colonial lines, as the new lines often are built close to them. Only one of the analysed segments, the Warri - Itakpe line in Nigeria, does not have a colonial line close by.

6 Empirical Strategy

As the placement of SGR lines may be endogenous to local economic conditions, an inconsequential line approach is implemented within a Difference-in-Differences design.

For many infrastructure projects, including the new SGR lines in SSA, the placement of these is likely not to be random. Rather, certain characteristics of cells will determine if they are serviced by the new railway. Pre-existing industries and infrastructure, as well as demographic variables such as population size and income of the inhabitants of a cell, may influence planners' decision of the line placement. Looking at Table 3, this also seems to be the case for the SGR lines, as they are placed among more populated and built-up areas, which are more polluted and brighter than the areas which do not have SGR lines close by. Hence, these omitted variables may cause

[2]The World Health Organization recommends that the average annual level of PM2.5 does not exceed 5 $\mu g/m^3$ and a daily average does not exceed 15 $\mu g/m^3$ (World Health Organization 2021).

Table 3: Summary Statistics for Pre-Construction Period

	Control group			Treated group			Treated - control	
	Mean	SD	Obs	Mean	SD	Obs	Diff	Norm. Diff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: *Djibouti*								
Nighttime Lights	-0.11	0.14	1292	0.04	0.39	39	0.16	0.53
Population	11.17	150.65	1292	106.90	529.41	39	95.73	0.25
Built-up surface, total	0.66	9.25	1292	94.19	561.52	39	93.53	0.24
PM2.5	24.75	1.89	1292	25.22	1.66	39	0.48	0.27
Distance to nearest SGR station	28.50	15.04	1292	3.33	1.19	39	-25.17	-2.36
Distance to nearest SGR line	23.44	14.15	1292	2.13	1.33	39	-21.31	-2.12
Distance to nearest colonial line	22.96	13.97	1292	2.23	1.71	39	-20.74	-2.08
Distance to nearest colonial station	23.96	13.37	1292	4.38	2.07	39	-19.58	-2.05
Panel B: *Ethiopia*								
Nighttime Lights	-0.08	0.38	12001	0.59	1.63	215	0.67	0.56
Population	111.46	698.07	12001	284.33	1183.64	215	172.87	0.18
Built-up surface, total	18.74	202.94	12001	162.22	644.12	215	143.48	0.30
PM2.5	26.05	4.20	12001	27.07	4.07	215	1.02	0.25
Distance to nearest SGR station	32.12	13.58	12001	3.33	1.18	215	-28.78	-2.99
Distance to nearest SGR line	24.92	14.29	12001	2.08	1.31	215	-22.85	-2.25
Distance to nearest colonial line	24.49	14.10	12001	4.74	5.41	215	-19.74	-1.85
Distance to nearest colonial station	26.66	12.84	12001	6.55	5.92	215	-20.11	-2.01
Panel C: *Kenya*								
Nighttime Lights	0.10	0.18	11972	0.52	0.65	192	0.42	0.88
Population	88.55	690.59	11970	339.88	790.35	192	251.33	0.34
Built-up surface, total	28.37	202.99	11970	249.22	762.21	192	220.85	0.40
PM2.5	15.65	1.97	11970	16.05	2.06	192	0.40	0.20
Distance to nearest SGR station	33.34	14.18	11972	3.31	1.17	192	-30.03	-2.99
Distance to nearest SGR line	25.00	14.32	11972	1.97	1.27	192	-23.03	-2.26
Distance to nearest colonial line	21.87	13.76	11972	4.27	4.15	192	-17.61	-1.73
Distance to nearest colonial station	23.96	12.74	11972	5.82	3.92	192	-18.14	-1.92
Panel D: *Nigeria*								
Nighttime Lights	-0.04	0.70	11563	0.11	0.85	402	0.16	0.20
Population	230.45	1421.83	11564	1589.40	5844.40	402	1358.96	0.32
Built-up surface, total	115.24	629.14	11564	640.24	1624.40	402	524.99	0.43
PM2.5	40.90	15.80	11564	40.63	15.84	402	-0.27	-0.02
Distance to nearest SGR station	27.83	13.30	11564	3.30	1.17	402	-24.52	-2.60
Distance to nearest SGR line	25.48	14.07	11564	2.09	1.31	402	-23.39	-2.34
Distance to nearest colonial line	19.01	12.58	11564	6.25	7.34	402	-12.76	-1.24
Distance to nearest colonial station	20.92	11.82	11564	9.97	7.47	402	-10.95	-1.11
Panel E: *Tanzania*								
Nighttime Lights	0.09	0.20	9619	0.35	0.65	191	0.26	0.53
Population	56.46	176.60	8991	389.20	1770.64	191	332.73	0.26
Built-up surface, total	39.19	263.44	8991	315.92	897.74	191	276.73	0.42
PM2.5	13.70	2.09	8991	13.60	2.03	191	-0.10	-0.05
Distance to nearest SGR station	29.56	13.14	8991	3.30	1.17	191	-26.25	-2.81
Distance to nearest SGR line	25.09	14.19	8991	2.07	1.31	191	-23.02	-2.29
Distance to nearest colonial line	21.84	13.96	8991	1.93	1.31	191	-19.91	-2.01
Distance to nearest colonial station	23.76	12.96	8991	3.63	1.73	191	-20.13	-2.18

Notes: Unit of observation is a 2×2 km grid cell, within a 50km buffer around each SGR segment. Average of each variable for periods before construction of respective segment. Normalized difference, following Imbens and Rubin (2015), calculated as $Norm_Diff = (treated_mean - control_mean)/(\sqrt{((treated_sd^2 + control_sd^2)/2)})$. Units of variables: nighttime lights - asinh(radiance) for countries with only VIIRS data (Kenya, Tanzania) or z-score for countries with VIIRS and CCNL data (Djibouti, Ethiopia and Nigeria). Population - headcount. Built-up surface - m^2. PM2.5 - $\mu g/m^3$. Distances - km.

endogeneity through correlation with the treatment variable ($HasStation_i$). To overcome this, an inconsequential line approach, as used by Alder (2025) and Chandra and Thompson (2000), is applied.

This inconsequential line approach relies on the assumption that a new railway line is being built with the aim of connecting two main places, and the intermediate towns will only be connected to the route if they are conveniently located along the line. Thus, the characteristics of a cell are deemed inconsequential to the placement of the route, as only the location is decisive. In Kenya for example, the first segment of the new SGR line connects the coastal town Mombasa to the capital Nairobi. For the intermediate towns, it will be assumed that the receipt of a station can be treated as an exogenous event. Thus, for the estimation, only those inconsequential places will be used, and the cells whose nearest station is a terminus will be excluded. The remaining cells are then classified as treated, as in they have an SGR station, if their centroid is within 5km[3] of a station; otherwise they are classified as control cells.

To identify the treatment effect through a Difference-in-Differences approach, two additional assumptions must be satisfied. First, for the Parallel Trends assumption to hold, the outcomes of treated cells must have followed the same trend as for the untreated cells, in the absence of treatment. By restricting the sample to only contain inconsequential places, this becomes a plausible assumption. Secondly, the No-Anticipation assumption must also be satisfied, meaning that before treatment starts, there must be no changes in the outcomes due to the treatment. To make this a plausible assumption, the pre-treatment period is defined as being before ground was broken for the construction of the SGR line. Additionally, the construction period will be excluded for the main specification, as the market-access effect is of interest here, and not the transitory construction impact on the outcomes. In an alternative specification, the construction period observations are kept, but the anticipation window is set to start at construction.

With these sample restrictions and assumptions in mind, the main estimation equation for the Difference-in-Differences design will take the following form:

$$Y_{it} = \lambda_i + \lambda_t + \beta(HasStation_i \times Post_{it}) + \varepsilon_{it} \tag{1}$$

where Y_{it} is a specific local economic development outcome of interest, e.g., nighttime lights, in cell i at time t and λ_i and λ_t capture cell and time fixed effects, respectively. The first absorbs all time-invariant characteristics of a cell that affect its baseline outcome level, such as whether it already has a colonial rail station, or is a persistently brighter or more populated place for reasons unrelated to the new railway, while the latter removes all shocks common to all cells in time t. $HasStation_i$ is an indicator that equals one if a cell has an SGR station, and $Post_{it}$ is a dummy equalling one in the periods after the segment on which the cell sits opens. The error term ε_{it} will be clustered at the ADMIN2-level to account for possible spatial correlation. With this equation, β then captures the causal effect of cell i receiving an SGR station in time t on the outcome of interest Y relative to those cells in the same ADMIN2 area that did not receive an SGR station.

[3] As railways do not provide last-mile transport, only to the SGR station, which may not lie directly in a town, a commutable distance (by foot or road-based transport) of 5km is chosen.

The estimation is performed at two levels: the segment (e.g., Mombasa - Nairobi in Kenya) and the corridor level. In Tanzania and Kenya, the second segments are both extensions of the first. Hence, this can be viewed as a staggered treatment along the corridor. For both estimation levels, the Callaway and Sant'Anna (2021) (CS) estimator is used. For the segment level, the setup collapses to a simple 2×2 Difference-in-Differences design, with treatment date, the segment-opening. For the corridor level estimation, there are two treated cohorts with different treatment timings. As a simple two-way fixed effects design would make forbidden comparisons using the already treated as a control group, resulting in wrong estimates, the CS estimator is used, which allows for multiple treatment periods[4]. The estimation equation then takes on the form:

$$Y_{it} = \lambda_i + \lambda_t + \sum_{\substack{k=-\underline{K} \\ k\neq -1}}^{\overline{K}} \beta_k \left(HasStation_i \times \mathbb{1}\{t - G_i = k\} \right) + \varepsilon_{it} \tag{2}$$

where G_i is the period in which the segment opens, on which cell i sits, $\underline{K}$ and $\overline{K}$ define the number of leads and lags, respectively. The reference period $k = -1$ is omitted from the estimation. β_k then captures the causal effect in period k of cell i having an SGR station on the newly opened line, relative to the last period before treatment.

7 Results

7.1 Main Results

In Table 4, the results from running the main estimation equation 1 at the segment level can be seen. Treated cells, as in those who have received an SGR station, are compared with those that did not (control cells), keeping everything else constant. If a country has multiple segments, such as Kenya, then the treated cells are only compared with control cells from the same segment, the control cells from the other segment within in the same country are dropped. The construction-period observations are excluded from this estimation, so that the post-opening observations are compared to the cells before ground was broken to avoid possible contamination. During construction, temporary buildings or lights may be constructed. Comparing against this, instead of the pre-construction period, may hence lead to the estimator picking up this construction-related changes, instead of just measuring the effect of the new, operational SGR line. Thus, Table 4 presents the average treatment effect for the treated cells (ATT) within the inconsequential places sample. Claims about the effect on cells that have or are close to a terminus or outside the 50km buffer cannot be made.

Regarding nighttime lights in column (1), some positive effects of the opening of the SGR lines can be observed, in line with Hypothesis 1. On average, the opening of the Mombasa - Nairobi segment in Kenya led to 0.12 unit increase in brightness, highly significant at the 1% level. In Tanzania, the effects are even more pronounced.

[4] See Goodman-Bacon (2021) and De Chaisemartin and D'Haultfœuille (2020) for a comprehensive review and motivation of this approach.

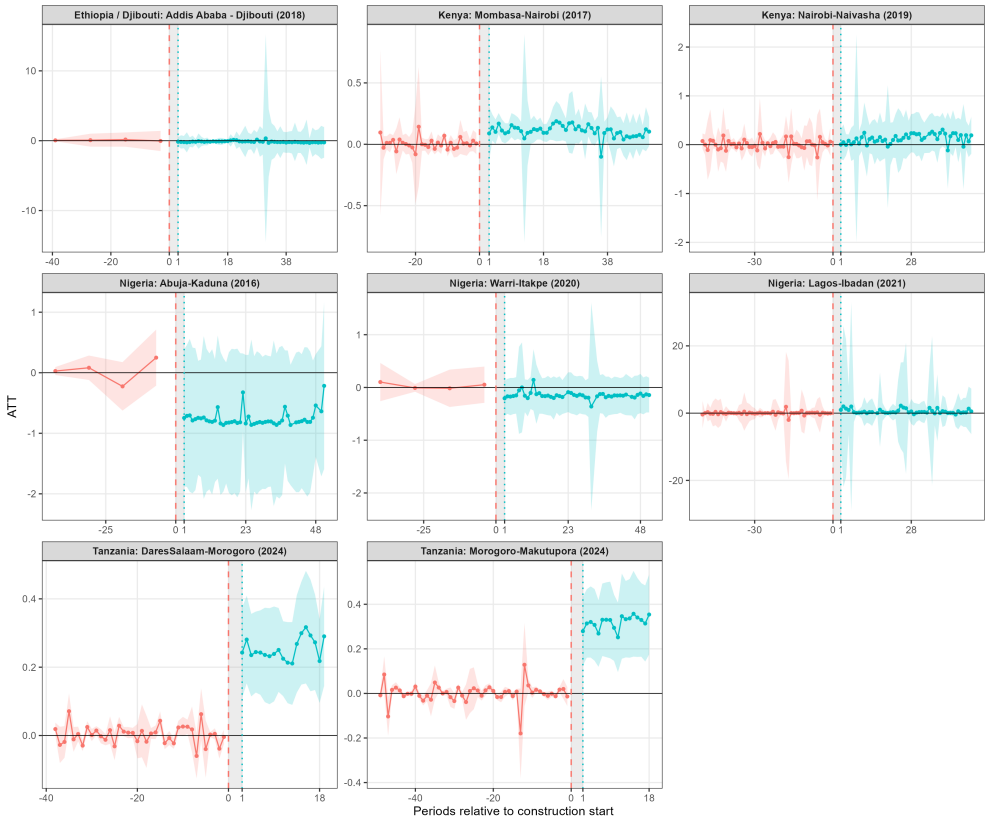
Table 4: Effect of SGR-Opening on Outcome Variables, Segment Level

Country	Segment [opening year]	Nighttime Lights (1)	Pollution (2)	Population (3)	Built-up Surface (4)
Ethiopia / Djibouti	Addis Ababa - Djibouti [2018]	-0.15	1.11	381.44	47.06
		(0.838)	(1.759)	(437.990)	(49.542)
		N=2255771	N=240776	N=267870	N=121669
Kenya	Mombasa - Nairobi [2017]	0.12***	-0.15	230.77	4.57
		(0.038)	(0.623)	(287.394)	(17.489)
		N=1825967	N=169245	N=191865	N=101655
	Nairobi - Naivasha [2019]	0.14	1.36***	440.74	0.47
		(0.168)	(0.304)	(1345.768)	(66.935)
		N=367049	N=35274	N=40000	N=21267
Nigeria	Abuja - Kaduna [2016]	-0.68	-0.15	493.23	39.70
		(0.600)	(1.572)	(382.917)	(24.458)
		N=248234	N=36210	N=39860	N=16367
	Warri - Itakpe [2020]	-0.15	0.66	172.34	42.90
		(0.148)	(0.759)	(163.860)	(43.056)
		N=853081	N=130330	N=143572	N=59209
	Lagos - Ibadan [2021]	0.53	-0.45	1079.59	48.96
		(1.517)	(2.080)	(10303.225)	(224.246)
		N=504570	N=69784	N=76824	N=31526
Tanzania	Dar es Salaam - Morogoro [2024]	0.25***	NA	125.02	7.31
		(0.043)	(NA)	(94.726)	(10.357)
		N=588499	N=NA	N=58695	N=33771
	Morogoro - Makutupora [2024]	0.32***	NA	34.26	-6.03
		(0.051)	(NA)	(94.244)	(19.914)
		N=799561	N=NA	N=81216	N=46686

Notes: ATT estimated via CS difference-in-differences at the segment level, using the never-treated cells as control. Standard errors from the multiplier bootstrap, clustered at the ADMIN2 level, except for Tanzanian segments, which are clustered at the cell to the small number of ADMIN2 clusters. All columns drop observations falling within each segment's own construction window. Nighttime lights measured as z-scores for Djibouti, Ethiopia, and Nigeria; as asinh(radiance) for Kenya and Tanzania. Pollution in $\mu g/m^3$, population measured as headcounts and built-up surface measured as m^2. Pollution data only available until 2022, hence not possible to estimate effects for Tanzania.

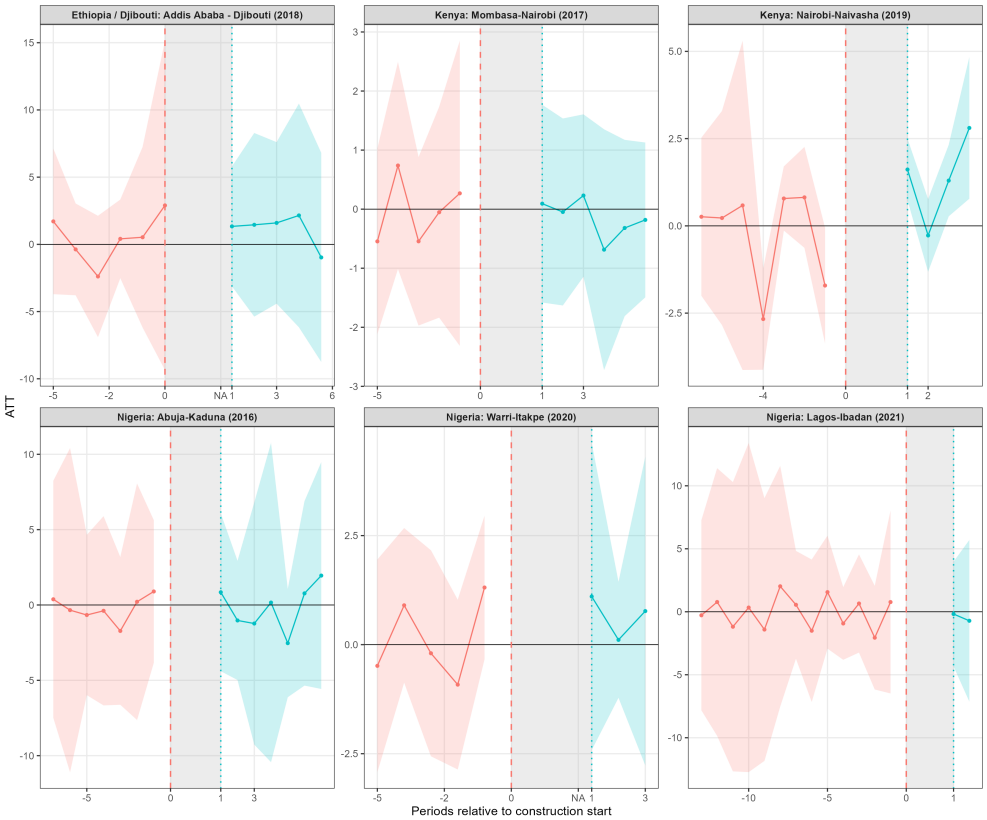
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Fig. 3: Event-Study for Nighttime Lights, Segment Level



Notes: Event-study version of column (1) in Table 4. Periods measured as months here. Nighttime lights measured as z-scores for Djibouti, Ethiopia, and Nigeria; as asinh(radiance) for Kenya and Tanzania. The construction period is dropped from the estimation, and its display is scaled down for better visibility of the coefficients. The red dots show the pre-treatment coefficients, the green dots those for the post-treatment periods. The shaded areas display the 95% confidence bands. Results displayed at the segment level, relative to the first period before construction starts, which is omitted from estimation.

Fig. 4: Event-Study for Pollution, Segment Level



Notes: Event-study version of column (2) in Table 4. Periods measured as years here. Pollution measured in $\mu g/m^3$. The construction period is dropped from the estimation, and its display is scaled down for better visibility of the coefficients. The red dots show the pre-treatment coefficients, the green dots those for the post-treatment periods. The shaded areas display the 95% confidence bands. Results displayed at the segment level, relative to the first period before construction starts, which is omitted from estimation.

Compared to those cells that did not receive an SGR station, those that did receive one on the new Dar es Salaam - Morogoro and the Morogoro - Makutupora lines experienced an increase in brightness at night. For the first segment, the nighttime lights increased by 0.25 units on average, whereas the treated cells along the Morogoro - Makutupora lines got brighter by 0.32 units on average, both highly significant at the % level. Taking the nighttime lights as proxies for local GDP for those areas, their increased brightness hints at increased economic activity in those areas, due to the new SGR line. For all other segments, no effects that are significantly different from 0 were observed.

Looking at the effect on pollution, displayed in column (2), only the Nairobi - Naivasha segment seems to have an impact. The opening of this line led to an increase in pollution of 1.36 $\mu g/m^3$ on average (significant at the 1% level), constituting an 8.7% increase compared to the control group. This may be due to multiple factors: for one, the new SGR trains on this line are diesel-powered, directly causing pollution. Additionally, getting to these new stations requires a transportation method for the last-mile, as trains only stop in designated areas. As shown by Salon and Gulyani (2019) for urban Kenyan areas, most urban commuting is done by walking or matatus, usually fossil-fuelled minibus-taxis. If the use of these increases due to the last-mile transport to the SGR stations, then this will also contribute to the elevated pollution levels. Furthermore, higher economic activity, as hinted by the increase in nighttime lights for this line, may also contribute to higher pollution levels. This is in line with the prediction for diesel-powered SGR segments from Hypothesis 3. However, for all other segments, including the other diesel-powered ones, the pollution levels seem to remain unchanged, with no results significantly different from 0.

For population and built-up surfaces, no changes are observed for any segment. While all point-estimates show a positive sign, they are all not significantly different from 0. On the one hand, this may hint that while for some segments, as shown above, the level of economic activities has increased, this did not lead to people moving closer to cities with an SGR station, constituting agglomeration effects. On the other hand, some segments, such as the two Tanzanian ones, have only opened recently. Hence, migration and construction effects may not be visible yet, in accordance with Hypothesis 2.

Figures 3 and 4 present the full event-study paths for nighttime lights and pollution. In both Figures, the vast majority of the estimates for the pre-treatment periods hover around 0 and are not significantly different from the reference periods across all segments, lending credibility to the Parallel Trends assumption.

After treatment, the opening of the specific SGR segment, the coefficients for nighttime lights remain insignificantly different from 0 for the segments in Nigeria, the Nairobi - Naivasha segment in Kenya, and the cross-border line in Ethiopia and Djibouti. Meanwhile for the Tanzanian segments, a clear positive and persisting effect becomes visible. Right when the lines open, the coefficients jump to 0.2-0.3 and stay there over time, hinting at a lasting effect of the new SGR lines on nighttime lights for the treated intermediate cells. For the Mombasa - Nairobi segment, the picture is less clear. The coefficients also increase to around 0.2, but they are not estimated as precisely and become insignificant after about 40 periods (about 3 years), possibly indicating that an initial spur of local economic activity vanishes later on. However, this timing also coincides with the COVID-19 pandemic, which unrelatedly led to decreased economic activity, possibly explaining the dip in nighttime lights.

For pollution, all segments have insignificant coefficients for all post-treatment periods, except for the Nairobi - Naivasha segment in Kenya. There, the levels of PM2.5 concentration in the air start at around 2 $\mu g/m^3$ before dipping below zero (though insignificantly) and then increasing to even higher levels. Again, the dip coincides with the pandemic, which restricted economic activity and movement of people, possibly explaining this finding.

Appendix Figures A1 and A2 show the event-studies for population and built-up surfaces. They show insignificant coefficients around 0 for pre-treatment periods, further supporting the Parallel Trends assumption, while also displaying insignificant results for the post-treatment periods. This may be because the new SGR lines do not motivate people to move to places closer to SGR stations, so agglomeration effects do not materialize. However, such effects may take time to build up, so they may not be visible in the data yet[5]. Additionally, some corridors may only unfold their full potential once completed. For Kenya, for example, two more segments extending the Mombasa - Nairobi - Naivasha corridor to Uganda, besides additional corridors, are planned (Mwangi 2026). Moreover, those segments that were constructed by Chinese state-operated firms are mostly also operated by Chinese workers for the first years[6]. Hence, no or only little local labour is employed, diminishing the possible positive effects on local incomes.

7.2 Robustness

The main results remain robust when the method of dealing with the construction period is changed. While Table 4 drops the construction period observations, to avoid that post-treatment coefficients pick up construction activity and not just changes from the actual operation of the line, Table A1 keeps those observations. Instead, as the CS estimator allows for anticipation, the anticipation periods a are set to contain all construction periods; the reference period is then $t-G_i-a$. The point estimates remain unchanged; only the standard errors change as the number of included observations increases. This leads to the estimated effect of the opening of the Abuja - Kaduna line in Nigeria on built-up surfaces turning weakly significant. This line is the first that opened among the segments analysed, allowing possible effects to build up over a longer time. It may indicate that agglomeration effects take time to materialize, here in the form of built-up surfaces, for people to live or work in.

Appendix Table A2 displays the results from including baseline covariates, namely the pre-construction levels in the four outcomes as well as a dummy indicating if a cell is close to a colonial-era station. This changes the previous unconditional Parallel Trends assumption to a weaker conditional version[7]. While the estimate for pollution along the Kenyan Nairobi - Naivasha segment stays almost unchanged, the estimates for nighttime lights along the Mombasa - Nairobi and Dar es Salaam - Morogoro change more visibly. They remain positive, though their point estimates more than halve and turn insignificant for the Mombasa - Nairobi segment.[8] This hints at the non-random placement of the SGR lines, already confirmed in Chapter 5.3.

For Kenya and Tanzania, the effects of the SGR opening are also estimated for the corridor level and displayed in Table 5. For both countries, the most-recently opened

[5] Tanzanian segments only opened in 2024, hence yielding only one post-treatment period.

[6] For the Addis Ababa - Djibouti line, operations were run by the Chinese Railway Construction Company for the first six years. In 2024, they were then handed over to the Ethiopian and Djiboutian governments Tarrosy et al. (2026).

[7] Conditional on these baseline levels, the outcomes of treated cells would, in the absence of treatment, have followed the same trend as those of control cells with the same baseline characteristics.

[8] The effect for nighttime lights along the Nairobi - Naivasha, Abuja - Kaduna, Lagos - Ibadan, and Morogoro - Makutupora segments cannot be estimated as, due to the conditioning, not enough within-segment variation is left.

segments each extend the previously opening segment, hence constituting a staggered setup[9].

Table 5: Effect of SGR Opening on Outcome Variables, Corridor Level

Country	Nighttime Lights (1)	Pollution (2)	Population (3)	Built-up Surface (4)
Kenya	0.21*	-0.10	301.62	16.70
	(0.120)	(0.498)	(1171.486)	(37.189)
	N=1955007	N=181854	N=206178	N=109323
Tanzania	0.29	NA	97.38	-1.72
	(0.300)	(NA)	(496.240)	(48.559)
	N=1262641	N=NA	N=127325	N=73265

Notes: ATT estimated via CS staggered difference-in-differences at the corridor level, using the not-yet-treated cells as control. Standard errors from the multiplier bootstrap, clustered at the ADMIN2 level, except for Tanzanian segments, which are clustered at the cell level due to the small number of ADMIN2 clusters. All columns drop observations falling within each segment's own construction window. Nighttime lights measured as z-scores for Djibouti, Ethiopia, and Nigeria; as asinh(radiance) for Kenya and Tanzania. Pollution in $\mu g/m^3$, population measured as headcounts and built-up surface measured as m^2. Pollution data only available until 2022, hence not possible to estimate effects for Tanzania.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Mechanically, the corridor level estimates are weighted averages of the segment level estimates, which is reflected in the resulting coefficients displayed. As they use more observations, including untreated cells from each other's segments, this introduces noise, explaining why significance is lost for the estimates. For Tanzania, the positive effect on nighttime lights disappears at the corridor level. For Kenya, the effect on nighttime lights is still positive, increasing to on average 0.21 units (significant at the 10% level), while the effect on pollution now is insignificant and the point estimate turns negative. Again, as these are weighted averages and the Mombasa - Nairobi segment, with a segment level estimate of -0.15, is nearly four times longer than the Nairobi - Naivasha segment, these results are not surprising.

[9]Nigeria has three SGR lines, each opening in a different year, but none of them are connected. Hence, they are not combined into one staggered DiD estimation here.

8 Discussion

Compared to the presented literature on current railway projects (see Chapter 2.1), the results found in this analysis are less clear. While Ahlfeldt and Feddersen (2018) find an 8.5% increase in local GDP for stations along a new High Speed Railway in Germany, the SGR only led to positive effects on nighttime lights in three out of the eight segments analysed here. The effects vary between 0.12 and 0.32 units, which constitute large increases compared to the pre-treatment period levels displayed in Table 3. Some of the increase likely stems from the stations and its lights fixtures itself, upward biasing the results. Further investigation is needed to see if the positive effects on nighttime lights are restricted to only the cell stations or also spread out beyond them. Additionally, the largest effects are found for those segments opened most recently, in 2024, limiting the number of post-opening observations available. It thus remains an open question whether those effects return towards 0, as the Mombasa - Nairobi Panel in Figure 3 indicates.

Data limitations also play another role in this study. All outcomes are remotely sensed variables, functioning as proxies for local economic development. Hence, these results are only partially comparable to studies that use directly measured GDP or income. Moreover, the effects measured here are ATT for inconsequential places, so no claims can be made for the effects of the SGR opening on cells with a terminus or for those further out. Only claims about local, partial-equilibrium effects can be made.

Furthermore, the estimation design relies on the assumption that control cells, those without an SGR station, are unaffected by the treatment. However, the SGR may create spillover effects, biasing the estimates. If, for example, a firm in a treated area now can produce more due to better market access, it may demand more labour. This may make it more attractive for workers living outside the treated cells to commute to work in the treated cells. Thus, possibly pollution also increases in those "control" areas due to the increased commuting, or their level of population may increase due to migrants moving there (possibly even instead of to the treated cells, which are usually more urban and hence may have higher rental costs). This contamination biases the estimates downwards.

Another possible source of bias comes from the COVID-19 pandemic. This created sudden, unexpected shocks to supply and demand across sectors. It also restricted movement of people, possibly directly impacting the usage of the new railway lines as a passenger transport method during the pandemic years. If this hit treated and control cells differently, then this threatens the Parallel Trends assumption. Despite this, pre-treatment coefficients remain close to zero for most segments, suggesting this potential bias is unlikely to be driving the main findings.

Another possible source of bias stems from the colonial railways. All SGR segments, except for the Warri - Itakpe segment in Nigeria, run close to a colonial line, hinting at non-random placement of the SGR lines (see Table 3). For those, the SGR reinstates or improves access, instead of instating a completely new transport method. As the estimates for the Warri - Itakpe segment are insignificant across all specifications, it may be the case that some of the effects for the segments with colonial railways close by are driven by this, especially in light of the persistent effects of these railways found by Jedwab and Moradi (2016).

For policy-makers, the results from this analysis hint at bigger questions: As of now, the new SGR lines seem to have limited effects on the local economies of the treated cells. Since these projects come at considerable costs (see Table 2), it remains to be seen if these investments pay-off. Some effects may take time to constitute themselves, for example if they include migration choices or construction work, while others depend on the local population for embracing this new method of transportation. If they are not adapted to the local context (e.g., too costly or unreliable), the uptake of the SGR may be low, limiting the effects on the local economy.

9 Conclusion

In summary, this paper looks at the impact of new SGR lines on the local economic development of five SSA countries, which have opened such railway lines since 2016. To estimate the effect, a staggered Difference-in-Differences design is used, following Callaway and Sant'Anna (2021). The sample is restricted to inconsequential places to address the endogenous placement of the railway lines. For the outcomes, four different remotely sensed outcomes are used as proxies for local economic effects, as direct measures such as GDP are not available at the necessary granularity.

For three out of the eight analysed segments (Mombasa - Nairobi in Kenya and both Tanzanian segments), an increase in nighttime lights is found, hinting at an increase in economic activity. Moreover, for the treated cells along the Nairobi - Naivasha segment in Kenya, pollution levels increase significantly. While the Kenyan nighttime lights effect survives aggregation to the corridor level, the effect for the Tanzanian segments, as well as the pollution result for Kenya, disappears. Furthermore, none of the new segments have an impact on the population and built-up surfaces, though possible agglomeration effects may not be visible yet. The estimates should be read as local market-access effects, with open questions around reallocation and agglomeration and the causal channel behind the nighttime lights results left to the extensions outlined above.

These findings contribute to the sparse literature on modern railway projects in developing countries, where most of the evidence on infrastructure projects stems from roads or the colonial era. As each SGR segment comes at a substantial cost, the mixed results should caution policy-makers when planning the new segments.

Appendix A Additional tables and figures

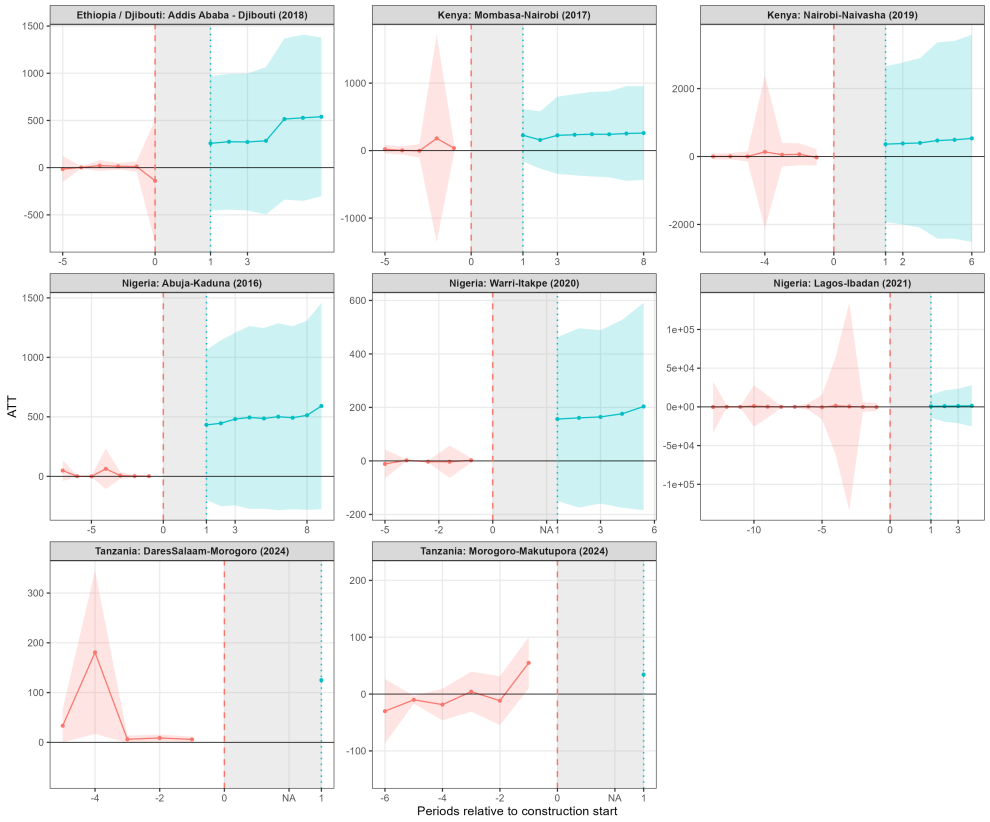
Table A1: Effect of SGR-Opening using Anticipation Window, Segment Level

Country	Segment [opening year]	Nighttime Lights (1)	Pollution (2)	Population (3)	Built-up Surface (4)
Ethiopia / Djibouti	Addis Ababa - Djibouti [2018]	-0.15	1.11	381.44	47.06
		(0.838)	(1.701)	(398.807)	(58.094)
		N=2273477	N=242515	N=269609	N=121923
Kenya	Mombasa - Nairobi [2017]	0.12***	-0.15	230.77	4.57
		(0.038)	(0.628)	(271.472)	(17.889)
		N=1829882	N=169650	N=192270	N=101790
	Nairobi - Naivasha [2019]	0.14	1.36***	440.74	0.47
		(0.162)	(0.291)	(1326.791)	(65.423)
		N=368992	N=35445	N=40171	N=21267
Nigeria	Abuja - Kaduna [2016]	-0.68	-0.15	493.23	39.70*
		(0.541)	(1.600)	(384.634)	(23.616)
		N=250779	N=36500	N=40150	N=16425
	Warri - Itakpe [2020]	-0.15	0.66	172.34	42.90
		(0.141)	(0.788)	(165.126)	(43.321)
		N=869209	N=132420	N=145662	N=59589
	Lagos - Ibadan [2021]	0.53	-0.45	1079.59	48.96
		(1.443)	(2.088)	(11031.462)	(208.801)
		N=511738	N=70400	N=77440	N=31680
Tanzania	Dar es Salaam - Morogoro [2024]	0.25***	NA	125.02	7.31
		(0.045)	(NA)	(93.894)	(10.176)
		N=594897	N=NA	N=59234	N=33848
	Morogoro - Makutupora [2024]	0.32***	NA	34.26	-6.03
		(0.052)	(NA)	(89.748)	(19.607)
		N=807720	N=NA	N=81900	N=46800

Notes: ATT estimated via CS difference-in-differences at the segment level, using the never-treated cells as control. Standard errors from the multiplier bootstrap, clustered at the ADMIN2 level, except for Tanzanian segments, which are clustered at the cell level due to the small number of ADMIN2 clusters. All columns use a segment-specific anticipation window to handle the construction period. Nighttime lights measured as z-scores for Djibouti, Ethiopia, and Nigeria; as asinh(radiance) for Kenya and Tanzania. Pollution in $\mu g/m^3$, population measured as headcounts and built-up surface measured as m^2. Pollution data only available until 2022, hence not possible to estimate effects for Tanzania.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Fig. A1: Event-Study for Population, Segment Level



Notes: Event-study version of column (3) in Table 4. Periods measured as years here. Population measured in headcounts. The construction period is dropped from the estimation, and its display is scaled down for better visibility of the coefficients. The red dots show the pre-treatment coefficients, the green dots those for the post-treatment periods. The shaded areas display the 95% confidence bands. Results displayed at the segment level, relative to the first period before construction starts, which is omitted from estimation.

Table A2: Effect of SGR-Opening Conditioning on Baseline Covariates, Segment Level

Country	Segment [opening year]	Nighttime Lights (1)	Pollution (2)	Population (3)	Built-up Surface (4)
Ethiopia / Djibouti	Addis Ababa - Djibouti [2018]	0.07	1.08	433.32	42.91
		(0.919)	(1.671)	(313.607)	(59.545)
		N=2255771	N=240776	N=267870	N=121669
Kenya	Mombasa - Nairobi [2017]	0.05	-0.21	238.47	0.76
		(1.293)	(0.392)	(2100.994)	(27.694)
		N=1825967	N=169245	N=191865	N=101655
	Nairobi - Naivasha [2019]	NA	1.37***	420.09	9.19
		(NA)	(0.337)	(1524.690)	(50.267)
		N=367049	N=35274	N=40000	N=21267
Nigeria	Abuja - Kaduna [2016]	NA	-1.58	493.59	16.91
		(NA)	(1.669)	(425.711)	(29.595)
		N=248234	N=36210	N=39860	N=16367
	Warri - Itakpe [2020]	-0.16	0.48	180.70	38.86
		(0.134)	(0.732)	(161.953)	(44.366)
		N=853081	N=130330	N=143572	N=59209
	Lagos - Ibadan [2021]	NA	-1.08	241.92	64.07
		(NA)	(2.133)	(6160.943)	(211.137)
		N=504570	N=69784	N=76824	N=31526
Tanzania	Dar es Salaam - Morogoro [2024]	0.11**	NA	-75.28	6.29
		(0.045)	(NA)	(130.594)	(10.35702)
		N=588499	N=NA	N=58695	N=33771
	Morogoro - Makutupora [2024]	NA	NA	-115.36	-14.39
		(NA)	(NA)	(175.349)	(19.900)
		N=799561	N=NA	N=81216	N=46686

Notes: ATT estimated via CS difference-in-differences at the segment level, using the never-treated cells as control. Controls for baseline levels in outcome variables and whether a cell has a colonial-era railway station. Standard errors from the multiplier bootstrap, clustered at the ADMIN2 level, except for Tanzanian segments, which are clustered at the cell level due to the small number of ADMIN2 clusters. All columns drop observations falling within each segment's own construction window. Nighttime lights measured as z-scores for Djibouti, Ethiopia, and Nigeria; as asinh(radiance) for Kenya and Tanzania. Pollution in $\mu g/m^3$, population measured as headcounts and built-up surface measured as m^2. Pollution data only available until 2022, hence not possible to estimate effects for Tanzania.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

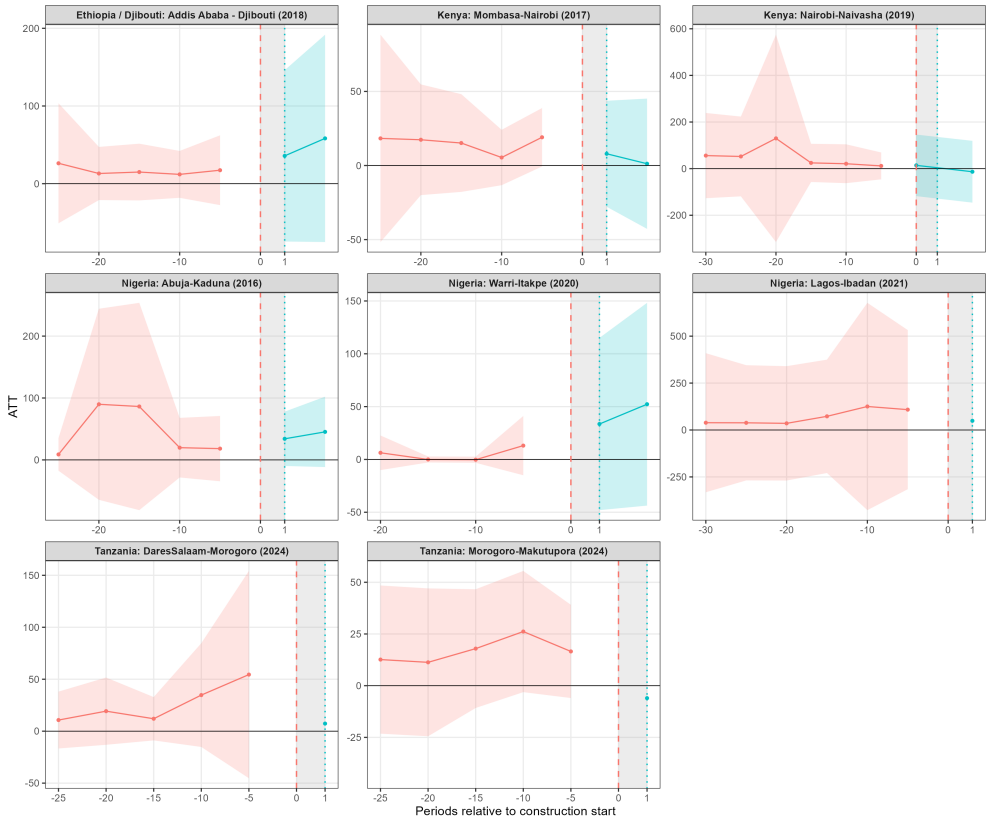
Table A3: Effect of SGR-Opening Conditioning on Baseline Covariates, Corridor Level

Country	Nighttime Lights (1)	Pollution (2)	Population (3)	Built-up Surface (4)
Kenya	0.11	-0.10	307.01	9.12
	(1.102)	(0.842)	(2718.604)	(69.642)
	N=1955007	N=181854	N=206178	N=109323
Tanzania	NA	NA	-157.69	-4.86
	(NA)	(NA)	(2430.424)	(56.801)
	N=1262641	N=NA	N=127325	N=73265

Notes: ATT estimated via CS staggered difference-in-differences at the corridor level, using the not-yet-treated cells as control. Controls for baseline levels in outcome variables and whether a cell has a colonial-era railway station. Standard errors from the multiplier bootstrap, clustered at the ADMIN2 level, except for Tanzanian segments, which are clustered at the cell level due to the small number of ADMIN2 clusters. All columns drop observations falling within each segment's own construction window. Nighttime lights measured as z-scores for Djibouti, Ethiopia, and Nigeria; as asinh(radiance) for Kenya and Tanzania. Pollution in $\mu g/m^3$, population measured as headcounts and built-up surface measured as m^2. Pollution data only available until 2022, hence not possible to estimate effects for Tanzania.

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Fig. A2: Event-Study for Built-Up Surfaces, Segment Level



Notes: Event-study version of column (4) in Table 4. Periods measured as 5-year intervals here. Built-up surface measured in m^2. The construction period is dropped from the estimation, and its display is scaled down for better visibility of the coefficients. The red dots show the pre-treatment coefficients, the green dots those for the post-treatment periods. The shaded areas display the 95% confidence bands. Results displayed at the segment level, relative to the first period before construction starts, which is omitted from estimation.

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