EFFECTS OF A NEW LIGHT-RAIL SYSTEM ON BUSINESS DENSITY: A DIFFERENCE IN DIFFERENCE STUDY

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Abstract

Existing research on the impacts of new transit systems on business behavior mostly investigates overall business openings and closures once a network has begun service, without accounting for nuance in the impacts of announcement, construction, and operation phases, economic sectors, and distance to stations. This study uses data from the Québec Business Registry to examine how the different phases of the Montréal Réseau express métropolitain (REM), a new light-rail (LRT) system, influenced service, retail, and knowledge business density within 500, 1000, and 1500 meters of stations. Our findings indicate that the REM caused statistically significant increases in business density across all three economic sectors near northern stations, with the strongest effects in the late-construction phase. The south stations did not experience statistically significant increases during the study period. These findings highlight the need for spatial and temporal nuance in research attempting to quantify the effects of new LRT on business density. Our results provide valuable insights for professionals aiming to support the establishment and maintenance of businesses near new LRT.

Résumé

Les recherches existantes sur l'impact des nouveaux systèmes de transport sur le comportement des entreprises examinent principalement les ouvertures et fermetures globales d'entreprises une fois qu'un réseau a commencé à fonctionner, sans tenir compte des nuances dans les impacts des différentes phases, des secteurs économiques et de la distance par rapport aux stations. Cette étude utilise des données du Registre des entreprises de Québec pour examiner comment les phases d'annonce, de construction et d'opération du Réseau express métropolitain (REM) de Montréal, un nouveau système léger sur rail, ont influencé la densité des entreprises de service, de vente au détail et du savoir dans une zone de 500, 1000, et 1500 mètres de stations dans la branche du Rive Sudet les branches nord. Nos résultats indiquent que le REM a provoqué des augmentations statistiquement significatives de la densité d'entreprises dans les trois secteurs économiques des autour des stations du nord, avec les effets les plus forts dans la phase de construction. La Rive-Sud n'a connu aucune augmentation statistiquement significative. Alors que les entreprises de services et de détail n'ont connu que des augmentations, nous constatons des résultats mitigés pour les entreprises techniques, avec des augmentations plus proches des stations et des diminutions plus éloignées des stations. Ces résultats soulignent la nécessité de plus de nuances dans les recherches visant à quantifier les effets des transports en commun sur le comportement des entreprises. Nos résultats fournissent des informations utiles aux agences de transport en commun, aux municipalités et aux urbanistes, les aidant à mieux coordonner et soutenir les entreprises à proximité des nouvelles infrastructures de transport en commun.

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INTRODUCTION

Introduction

Public transit plays a crucial role in cities' efforts to address climate change and economic development (Akin & Kara, 2020; Cervero, 2013), and is increasingly positioned as an important component of sustainable urban development (OECD/ITF, 2024). In particular, Light Rail Transit (LRT) can help reduce emissions through mode shift (Boarnet et al., 2017; Sohoni et al., 2017) and stimulate local economies through increases in property and land values (Atkinson-Palombo, 2010; Mulley et al., 2018). Work examining public transit's effects on firm behavior has shown that accessibility changes associated with new public transport infrastructure can influence firm location choice and lead to firm agglomeration and clustering around stations (Champagne & Dubé, 2023; Iseki & Eom, 2019; Mejia-Dorantes et al., 2012; Song et al., 2012). These effects may be stronger when transit investments are accompanied by other transit-oriented development policies, including zoning reforms permitting greater density and mixed land use (Iseki & Eom, 2019; Schuetz et al., 2018; Yu et al., 2018). However, less attention has been paid to whether such projects generate business growth, rather than simply reshaping the spatial distribution of firms, and to the varying effects across the announcement, construction, and operational phases of a project. This gap is important because transit investments are often justified in terms of local economic development, yet their benefits may emerge unevenly over time and across space. While some studies suggest that all phases of a public transport project can benefit businesses around stations (Champagne et al., 2024; Liu & Bardaka, 2023, 2025), others indicate that some businesses may suffer, particularly during construction when accessibility levels may be temporarily reduced (Tornabene & Nilsson, 2021).

Introduction

This study examines the effects of the Réseau Express Métropolitain (REM), a new LRT system in Montréal Canada, on business density over time, with special focus on service, retail, and knowledge sector businesses. The analysis relies on business registry data collected between 2012 and 2025. Using the phased implementation of the REM as a natural experiment, the study applies a difference-in-differences (DiD) approach to estimate business density changes around REM stations within 500, 1000, and 1500 meters over time. The treatment areas are defined around REM stations and distinguished between the south branch and the northern branch to account for the spatial and temporal variations. For the control group we selected dissemination areas (DA) across the Montréal Census Metropolitan Area (CMA) that have similar business density and distance to downtown compared to treatment areas (stations areas). Temporally, the analysis compares yearly changes relative to a pre-treatment baseline and later interprets those yearly estimates in relation to the project timeline, namely the announcement, construction, and operational phases. The operational phase applies only to the south branch, as it was the only branch in operation within the study period long enough to be considered operational in the analysis. Because the REM is expected to improve accessibility, the study hypothesizes that business density around REM stations will increase relative to both the pre-treatment period and the control areas, although the magnitude and timing of these effects may vary across branches, distance radii, and sectors.

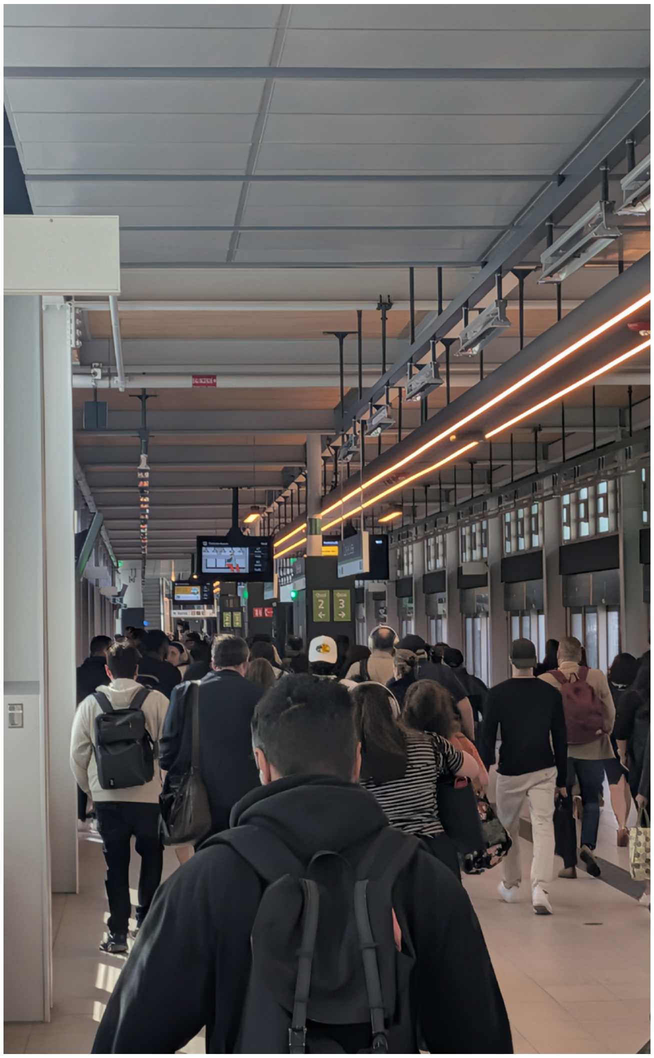
This paper contributes to the limited literature examining phase-based effects of major transit infrastructure projects on local business growth. By focusing on business density rather than broader business activity alone, and by distinguishing effects across sectors and phases, the analysis provides a more nuanced account of how firms respond to transit investments. If positive effects emerge early in the project timeline, this suggests that anticipated accessibility or market expectations may begin shaping business formation before operations start. Conversely, if some phases produce limited or negative effects, particularly during construction, the findings can help planners and policymakers design mitigation strategies to protect vulnerable firms and better align transit investments with local economic development goals.

LITERATURE REVIEW

Literature Review

Existing research on the land use and transport cycle can provide a useful theoretical framework for understanding how public transit investments may influence the number of businesses located near stations (Liu & Bardaka, 2025). In this framework, changes in the transport system are expected to alter accessibility levels, understood as the potential to reach opportunities, such as jobs, retail and activities (Giuliano & Agarwal, 2004; Hansen, 1959). Changes in accessibility can then reshape land use patterns, which in turn influence activity patterns (Giuliano & Agarwal, 2004; Hansen, 1959), such as commuting, shopping, and other daily travel. Over time, these changing activity patterns may generate further adjustments to the transport systems, completing the cycle.

Applied to transit station areas, this framework suggests that new public transit infrastructure may increase business presence through several linked mechanisms. Evidence from LRT suggests that improved accessibility can raise the attractiveness of nearby land, contributing to higher land values, property values, and rents around stations (Atkinson-Palombo, 2010; Ganning & Miller, 2020; Mohammad et al., 2013; Mulley et al., 2018; Sohoni et al., 2017). Public transport investments have been associated with greater housing and commercial density in station areas (Duffhues & Bertolini, 2016) promoting more activities such as commuting trips, errands, and tourism (Duffhues & Bertolini, 2016; Schuetz, 2015). As land uses intensify and more activities concentrate around stations, these areas may experience an increase in pedestrian volumes facilitating more customer interactions and sales (Ganning & Miller, 2020; Glaeser et al., 2008; Schuetz, 2015). These conditions may create a more favorable environment for retail, service, and knowledge businesses. While this broader framework is well established, less research has directly



Literature Review

examined whether public transport projects lead to business growth in surrounding areas. In other words, although existing work helps explain why transit investments may create conditions that attract firms, evidence on whether these projects are associated with an increase in the number of businesses remains more limited.

2.1 Transit projects effects on business starts, stops, and longevity

Research seeking to quantify business growth associated with new public transit infrastructure has generally done so indirectly, through indicators such as business starts, exits, and longevity (Champagne et al., 2024; Chatman et al., 2016; Iseki & Eom, 2019; Liu & Bardaka, 2023, 2025; Schuetz, 2015). These measures provide insight into whether transit investments create conditions supporting business supporting business formation, reduce business closures, and improve business survival around stations. Studies have found that new public transit often leads to increases in firm starts, decreases in exits, and improvements in longevity of nearby businesses (Champagne et al., 2024; Chatman et al., 2016; Credit, 2018; Credit, 2019; Liu & Bardaka, 2023, 2025). In some cases, transit investments are associated with increases of roughly 50% in firm starts for certain types of businesses (Chatman et al., 2016; Credit, 2018; Credit, 2019), and even larger gains for knowledge-sector firms or firms with more than five employees (Chatman et al., 2016; Credit, 2018). Other studies suggest that station areas may also experience a substantial reduction in retail closures (Liu & Bardaka, 2023) and improved firm survival following transit investments (Champagne et al., 2024; Liu & Bardaka, 2025).

However, the evidence is not uniformly positive. Some research finds that transit projects can negatively affect businesses around stations (Ray, 2017; Schuetz, 2015). For instance, in the case of Sacramento, California, a new transit line's inauguration was estimated to have decreased the number of retail employees per square mile by 70% (Schuetz, 2015). Similarly, in Los Angeles, the construction of a new transit line led to a 46% increased risk of business failure around stations (Ray, 2017). Overall, this literature suggests that public transit investments can support businesses around stations, but that the direction and magnitude of these effects can vary considerably across contexts. It also indicates that starts, exits, and longevity provide only a partial picture of business growth, as they do not directly capture whether transit projects lead to broader changes in overall business density around stations over time. In this sense, a more nuanced approached is required when modeling the effects of public transit on businesses.

Literature Review

2.2 Impacts of distance and project phase

Two important factors that may influence estimated business effects of new transit infrastructure are distance from stations and the phase of project implementation. Existing studies generally show that the effects of transit investments on business growth and longevity can remain significant up through approximately one mile from transit stations (Bardaka et al., 2019; Champagne et al., 2024; Chatman et al., 2016; Credit, 2018; Dubé et al., 2014; Liu & Bardaka, 2023, 2025). At the same time, most studies find that these effects weaken with increasing distance from stations, whether measured through business starts, closures, or longevity (Champagne et al., 2024; Chatman et al., 2016; Credit, 2018; Liu & Bardaka, 2023; Yao & Hu, 2020). This pattern is consistent with the land use and transport cycle: because accessibility gains are greatest closest to stations, impacts on surrounding land uses and business activity are also expected to be strongest in these areas.

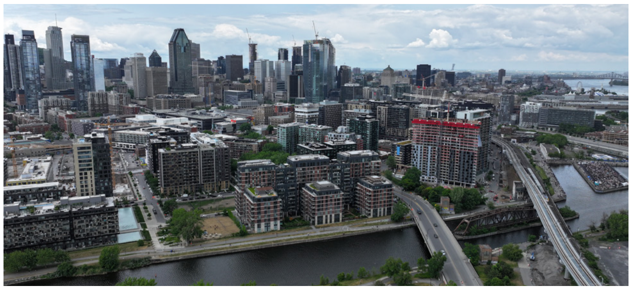
Evidence on phase-based effects is less consistent. Much of the literature focuses on the effects of transit projects after operations begin (Chatman et al., 2016; Credit, 2018; Iseki & Eom, 2019; Song et al., 2012), while only a limited number of studies examine how business outcomes vary across the announcement, construction, and operational phases of the project. Among those who do, findings are mixed (Champagne et al., 2024; Liu & Bardaka, 2023, 2025). In Charlotte, North Carolina, Liu and Bardaka (2023) found that effects for retail businesses around the LYNX light rail blue line were largest during the announcement phase, with decreasing strength as the project advanced through the construction and operation phases. In a later study of the same project, Liu and Bardaka (2025) found that certain retail and service businesses experienced the greatest benefits between five and ten years after the project began service. Champagne et al. (2024) found that phase effects around Montréal Metro stations varied by distance: within 250 to 500 meters, effects on business longevity were stronger for businesses opening during the construction phase, whereas within 1000 to 1250 meters, the largest effects were observed during operations, followed by the construction and announcement phases (Champagne et al., 2024).

Overall, the existing literature suggests that while business effects tend to decline as distance from stations increases, there is no consistent evidence on whether the strongest impacts occur during announcement, construction, or operation. This lack of clarity highlights the need for research examining how business outcomes evolve across project phases and station-area catchments.

Literature Review

2.3 Heterogeneity of effects based on economic sector

For a more nuanced understanding of how businesses are affected by transit projects, some research has examined whether impacts differ across economic sectors (Champagne et al., 2024; Credit, 2018; Iseki & Eom, 2019; Liu & Bardaka, 2023, 2025; Song et al., 2012; Yao & Hu, 2020). Exploring differences across business sectors is important because transit investments may not affect all businesses in the same way: some business types may depend more heavily on pedestrian activity, while others may be more sensitive to disruptions or rising rents. Within this literature, service and retail sectors have received most attention, with some focus on businesses in the knowledge sector, including finance, insurance, real estate (FIRE) as well as professional services such as law firms, consulting firms, and software companies (Champagne et al., 2024; Credit, 2018; Iseki & Eom, 2019; Liu & Bardaka, 2023, 2025; Yao & Hu, 2020). Existing findings suggest that all three types of businesses benefit from proximity to new transit infrastructure (Champagne et al., 2024; Credit, 2018; Liu & Bardaka, 2023, 2025; Yao & Hu, 2020), although the magnitude and timing of these effects vary across cases. In Montréal, a metro extension was associated with the greatest gains for retail businesses relative to other sectors (Champagne et al., 2024). In Phoenix, Arizona, a new LRT project was linked to increases across sectors, with the strongest effects for knowledge firms, followed by service, then retail businesses (Credit, 2018). The development of an urban rail line in Hangzhou, China led to increases in retail and technology business starts, with the greatest benefit for retail (Yao & Hu, 2020).



Evidence from Charlotte's LYNX light rail, in North Carolina, suggests that business sector effects vary by project phase: while the project was associated with positive effects for retail businesses, service businesses experienced both positive and negative effects depending on the phase considered (Liu & Bardaka, 2025). For instance, the number of new service business openings declined during construction, although existing service businesses did not experience a corresponding increase in risk of closure (Liu & Bardaka, 2023). Overall, this literature indicates that sector-specific effects are heterogeneous across regions and project phases. This reinforces the need to examine service, retail, and knowledge businesses separately when assessing how new transit infrastructure shapes local business activity over time

STUDY CONTEXT

Study Context

First announced in 2016, the Réseau express métropolitain (REM) was designed to expand rapid transit coverage across the Montréal region through a 67-kilometer automated network that will include 26 stations when fully complete (Figure 1). The project was announced as a way to redefine urban mobility in the region while bringing economic development, protecting the environment, and valorizing heritage and community (REM, 2026). Construction began in 2018, and the first operating segment, the South Shore branch between Brossard and Gare Centrale, opened in late July 2023. The second branch between McGill station and Deux-Montagnes opened in late November 2025. Because this study uses business registry data from 2012 to 2025 (before the opening of the second branch), the South Shore branch is the only part of the REM in operation during the study period, while the rest of the network remains in the announcement and construction phases (Figure 2). For the purposes of this paper, the REM is divided into the South Shore branch and the northern branches. This distinction is analytically useful because it separates the portion of the network where early operational effects can be examined from those where only announcement and construction effects can be assessed during the study period.

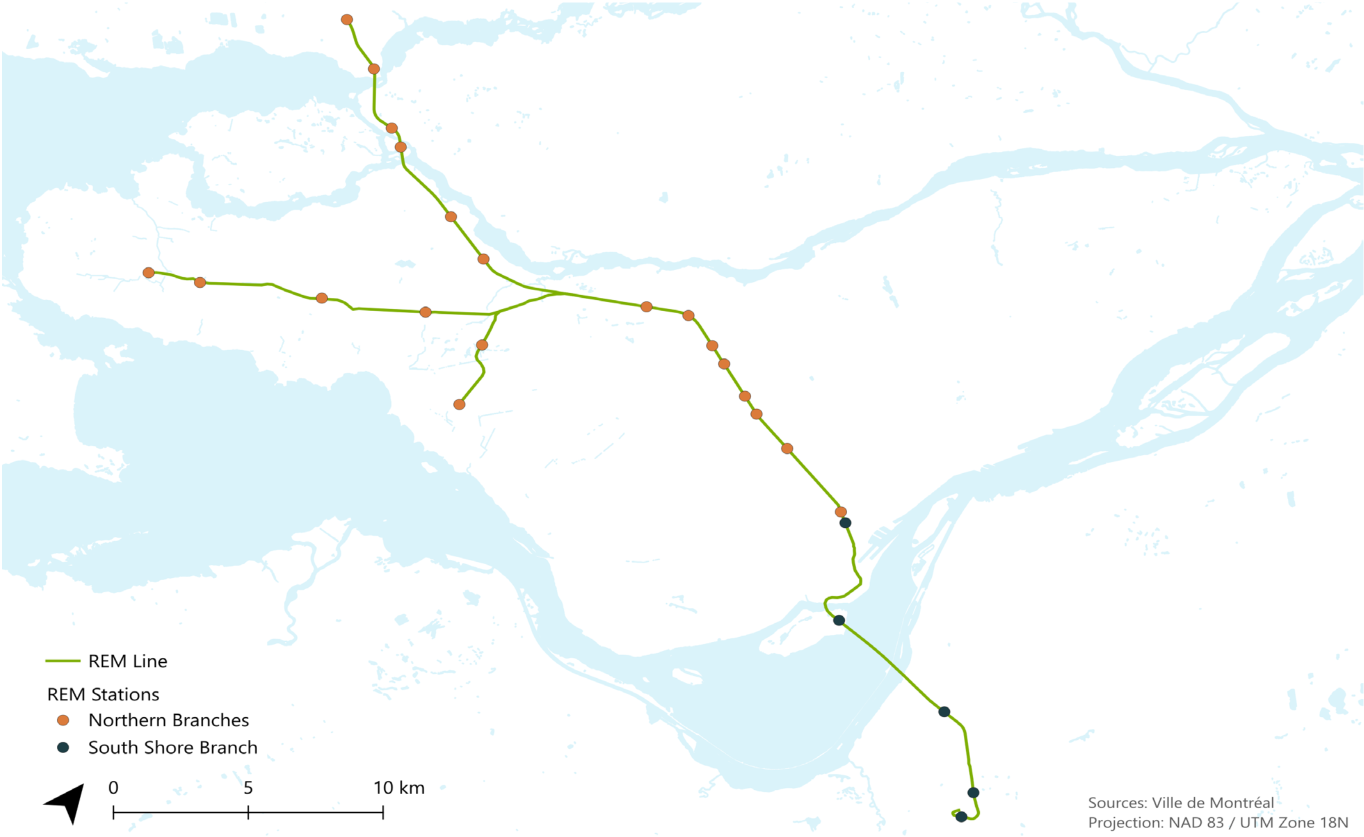


Figure 1. REM Stations and Branches

Study Context

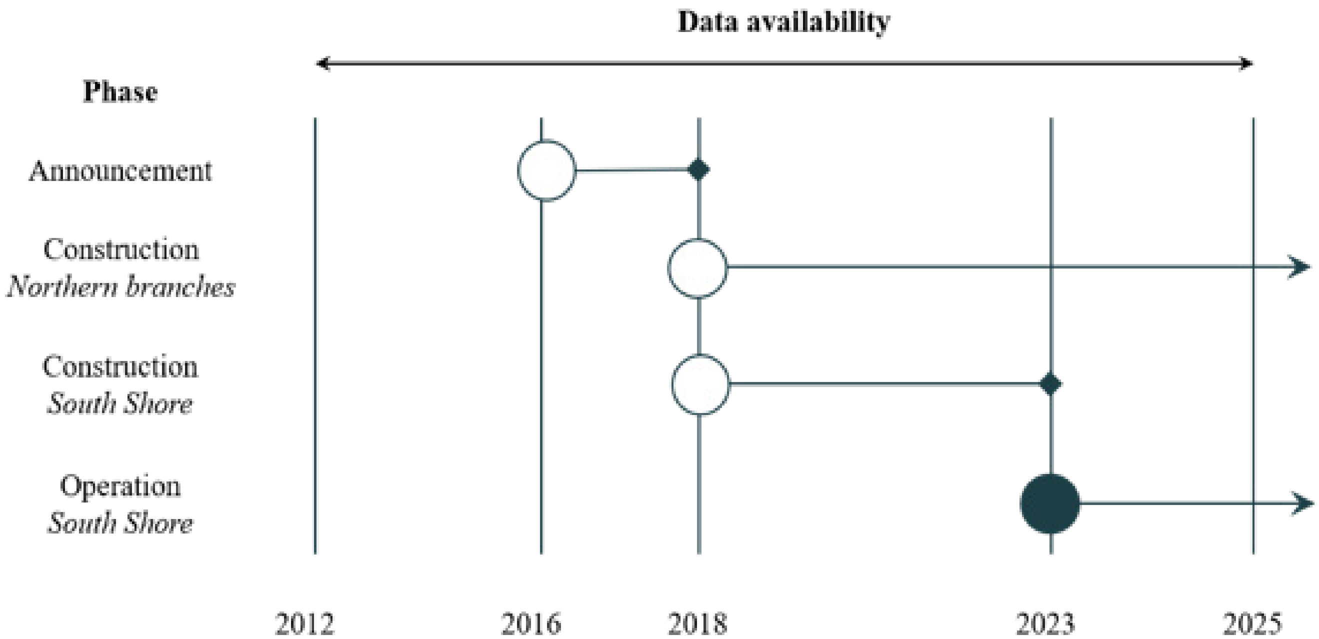


Figure 2. Timeline of the REM Project

DATA & METHODS

Data & Methods

4.1 Business Registry Data

This study examines how the REM affected the density of businesses over time in the Montréal region. Data on individual businesses were obtained from the Québec business registry, which serves as the official record of businesses in the province since 1994 (Québec, 2026). Each business is associated with a unique identifier, a registration date, a closing date, a physical address, and an economic sector code based on the code d'activité économique (CAE), which is Québec's equivalent of the North American Industry Classification System (NAICS). The registry data distinguishes between head-office and non-head-office business locations, with both datasets containing similar attribute information. However, because the publicly available registry only provides robust historical information for head offices, additional location-level data were obtained through an information request to the Québec government. This allowed the analysis to include both head offices and other business establishments.

Because the REM was announced in 2016, businesses that were closed before 2012 were filtered out from the dataset. This allows for four years of pre-treatment data to establish a baseline for identifying changes in business density prior to the REM's implementation. The listed postal code in the address filed was used to spatialize the establishments in the business registry data. Because addresses were entered manually by businesses, many contained minor inconsistencies that would reduce the reliability of direct coordinate geocoding. Postal codes were preferred as they were more consistently recorded and, given that Montreal postal are geographically small compared to the catchment areas, introduce negligible spatial imprecision. Although all businesses and locations contained address fields, many records did not include valid Canadian postal codes. To address this issue, missing or invalid postal codes were identified through geocoding using Geocode by Awesome Table in Google Sheets. This tool uses the address field provided in the registry to retrieve the most likely formatted address from Google Maps. The resulting output made it possible to assign a postal code to all businesses in the sample. As the study focuses on the Montréal CMA, businesses located outside this region were excluded. The three economic sectors examined in this study are service, retail, and knowledge. In this study, service businesses are classified as CAE codes 9100-9799, retail businesses as 6000-6599, and knowledge as 7100-7799. A more detailed breakdown of business types by sector can be seen in Table 2 in the appendix.

4.2 Difference-in-Differences Modeling Design

To estimate the effects of the REM, a new public transit investment, on business density, this study adopts a difference-in-differences (DiD) design that combines spatial and temporal comparisons. DiD is well suited to this setting because it helps distinguish the effects of the REM from broader temporal trends and pre-existing differences between treatment and control areas that are not attributable to the project (Craig et al., 2017). A key challenge in this type of approach is that treatment and control areas may differ systematically prior to the intervention, which can bias treatment effect estimates if not properly addressed (Humphreys et al., 2016). Specifically, DiD relies on the assumption that, in the absence of the intervention, treatment and control areas would have followed similar trajectories over time (Craig et al., 2017). However, even if these areas are selected to be as comparable as possible at baseline, some pre-existing differences typically remain.

In the transit and business literature, treatment areas are commonly defined using buffers around new transit stations, with buffer sizes varying according to the spatial scale at which impacts are expected to occur (Champagne et al., 2024; Chatman et al., 2016; Credit, 2018; Liu & Bardaka, 2023, 2025). Control areas are defined in different ways. In some cases, they consist of the broader region in which the project is located (Chatman et al., 2016; Iseki & Eom, 2019; Yao & Hu, 2020). In others, they are selected as areas not directly affected by major transit investments but displaying similar baseline characteristics and trends to the treatment areas (Champagne et al., 2024; Credit, 2018; Liu & Bardaka, 2023, 2025).

Data & Methods

In this study, treatment areas are defined as buffers around REM stations and are separated into the South Shore branch and the northern branches. To assess whether effects vary with proximity to stations, three distance radii around REM stations are modeled separately: 0.5km, 1km, and 1.5km. Six control groups are selected, one for each distance radii along the South Shore branch and the northern branches. For each treatment group, a corresponding control group of dissemination areas (DAs) was selected using a one-to-one matching procedure based on pre-treatment conditions. Matching was conducted using 2012 sector-specific business density as the primary criterion. Treatment DAs were first matched to control DAs with identical business density values within the same business sector. For treatment DAs that remained unmatched, matching was repeated using progressively broader business-density categories obtained by rounding density values to increasingly larger intervals. When multiple candidate controls satisfied the business-density criterion, the control DA with the most similar distance to downtown Montreal was selected. Matching was performed without replacement, ensuring that each control DA was used only once. This procedure produced six control groups, corresponding to the three distance radii for both the South Shore and northern REM branches. These selection criteria led to control groups that are likely to experience similar business growth outside of the REM's influence. Two REM stations, Gare Centrale from the South Shore branch and McGill from the northern branches, were excluded from the analysis due to their proximity to downtown and their high business density which skewed results in favour of our hypotheses. Using these treatment and control areas, the analytic sample includes 89,616 businesses across all models. A breakdown of the number of businesses in individual models can be seen in Table 1.

The temporal dimension of the models is specified using year fixed effects. Since the REM was officially announced in 2016, the pre-treatment reference period is limited to 2012–2015 (REM, 2018). Year-specific interaction terms between treatment status and year are then used to estimate how business density in REM station areas changed relative to the control group and pre-treatment baseline. A total of six models are estimated for each business sector, three for each catchment area in the South Shore branch and three for each catchment area in the northern branches. Although the models are estimated annually, the resulting yearly treatment effects are later interpreted in relation to the project timeline, namely the announcement, construction, and South Shore operational phases. Importantly, the operational phase refers only to stations on the South Shore branch, as this was the only REM branch that started operation within

Data & Methods

the study period. Because of our limited sample size in the South Shore catchment areas of 0-500 metres across all three business sectors, we estimate phase-specific treatment and fixed effects terms rather than year-based effects to ensure the models can reliably estimate the effects of the REM. The empirical specification for the year-based models can be defined as follows:

$$Y_{it} = \beta_0 + \beta_1 Treatment_i + \sum_t \gamma_t Year_t + \sum_t \delta_t (Treatment_i \times Year_t) + \beta_3 X_{it} + u_i + \varepsilon_{it}$$

Service Businesses (N=)

Catchment Area	South Shore Branch		Northern Branches	
	Treatment	Control	Treatment	Control
0-500	1,206	182	2,688	2,043
501-1000	1,919	556	4,891	4,304
1001-1500	2,167	954	6,948	6,209

Retail Businesses (N=)

Catchment Area	South Shore Branch		Northern Branches	
	Treatment	Control	Treatment	Control
0-500	978	127	2,994	1,730
501-1000	1,461	399	4,789	3,734
1001-1500	1,651	635	6,014	4,676

Knowledge Businesses (N=)

Catchment Area	South Shore Branch		Northern Branches	
	Treatment	Control	Treatment	Control
0-500	3,454	434	10,993	4,954
501-1000	5,994	1,392	17,810	10,404
1001-1500	6,398	2,315	22,562	14,631

Table 1. Analytic Sample by Sector, Branch, and

Data & Methods

This specification extends the baseline difference-in-differences formulation with a single treatment indicator based on year. Separate models are run for the South Shore branch and northern branches to accommodate the spatially differentiated nature of the REM project. These treatment indicators are interacted with year fixed effects to estimate year-specific treatment effects relative to the omitted control group and the omitted pre-treatment reference time period, allowing treatment effects to vary over time and across REM branches rather than imposing a single average post-treatment effect.

In this model, Y*it* represents the natural log of business density in dissemination area (DA) *i* in year *t*. Treatment *i* indicates whether a dissemination area belongs to the treatment areas or the control areas. Year *t* represents year fixed effects, while γ*t*, δ*t*, and θ*t* denote year-specific coefficients. The summation notation indicates that the model includes a separate coefficient for each year dummy and for each treatment-by-year interaction, with one pre-treatment period (2012-2015) omitted as the reference category. The interaction term (Treatment × Year *t*) reflects the average treatment effect in year *t*. These coefficients show how business density in REM station areas differs from the control group in each year relative to the pre-treatment period. Thus, these terms are the most relevant for this study as they isolate the impact of the intervention from spatial and temporal differences. X *it* is a vector of control variables, including population density, median income, and Can-ALE's dwelling density index. Finally, u *i* represents a dissemination-area-level random intercept, which accounts for unobserved time-invariant differences across areas. The variance of these random intercepts, τ_{00}, captures between-DA heterogeneity in baseline business density, while σ^2 denotes the residual within-DA variance. The ratio τ_{00} / ($\tau_{00} + \sigma^2$) gives the intraclass correlation, reflecting the degree to which repeated observations within the same DA are correlated. The empirical specification for the phase-based models replaces the Year_t term and the (Treatment ×Year *t*) term with Phase *t* and (Treatment *i* × Phase *t*). No other changes are made. The DiD models were all estimated through multilevel linear regression. Separate models are estimated for each distance radii and economic sector, i.e. service, retail, and knowledge sectors. All regressions are estimated using the lme4 package in R (Bates et al., 2015). For ease of interpretation, regression coefficients are converted to percentage changes using the following formula:

$$\%\Delta \mathrm{Y} = (\mathrm{e}^{\beta} - 1) \times 100$$

RESULTS

Results

5.1 Descriptive Statistics

Descriptive statistics for the three confounding variables are presented in the appendix in Figures 12-17 and Table 3. Both population density and median annual income increase over time across all branches and catchment area sizes. In the South Shore, population density is higher in the control dissemination areas (DA) than in the treatment DAs. In the northern branches, population density is similar between control and treatment DAs. Median income is higher in the treatment DAs than in the control DAs across all branches and catchment areas. As Can-ALE's dwelling index data was only available for the year 2018, we are unable to measure it's change over time. In 2018, the control DAs had higher dwelling count z-scores than their matching treatment DAs across all branches and catchment areas. In all catchment areas, the control DAs experience higher dwelling count z-scores than the treated DAs. This trend is stronger in the South Shore than in the northern branches.

5.2 Exploratory Analysis

Before estimating the DiD model, Figures 3-5 show business growth per km^2 across the control and treatment areas and within the three catchment areas. Across all branches and catchment areas, business density increases over time. Due to the control selection criteria which match dissemination areas (DA) based on business density in 2012, all branches and catchment areas show similar business density between control and treated DAs in 2012. Between branches, the South Shore experiences lower business density than the northern branches across all years. Business density grows at a slightly faster rate in South Shore control DAs than in treatment DAs. In the northern branches, business density in the treatment DAs grows faster than in the control DAs, with the greatest difference in the largest catchment area. In both branch groups, trends in business density begin to diverge more substantially following the announcement and start of construction. The similarity in pre-announcement trends between treatment and control areas provides support for the parallel trends assumption, lending credibility to the DiD design.

Results

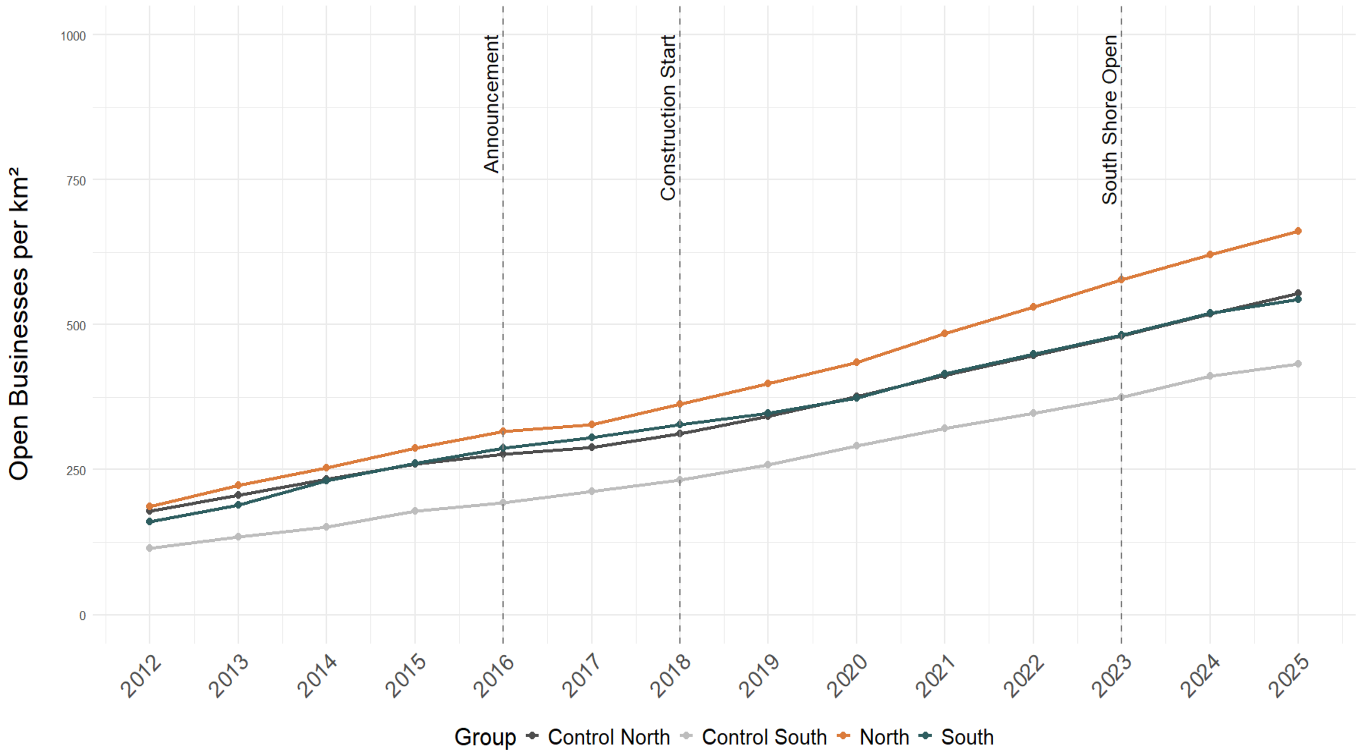


Figure 3. Open businesses per km² (0-500 meters)

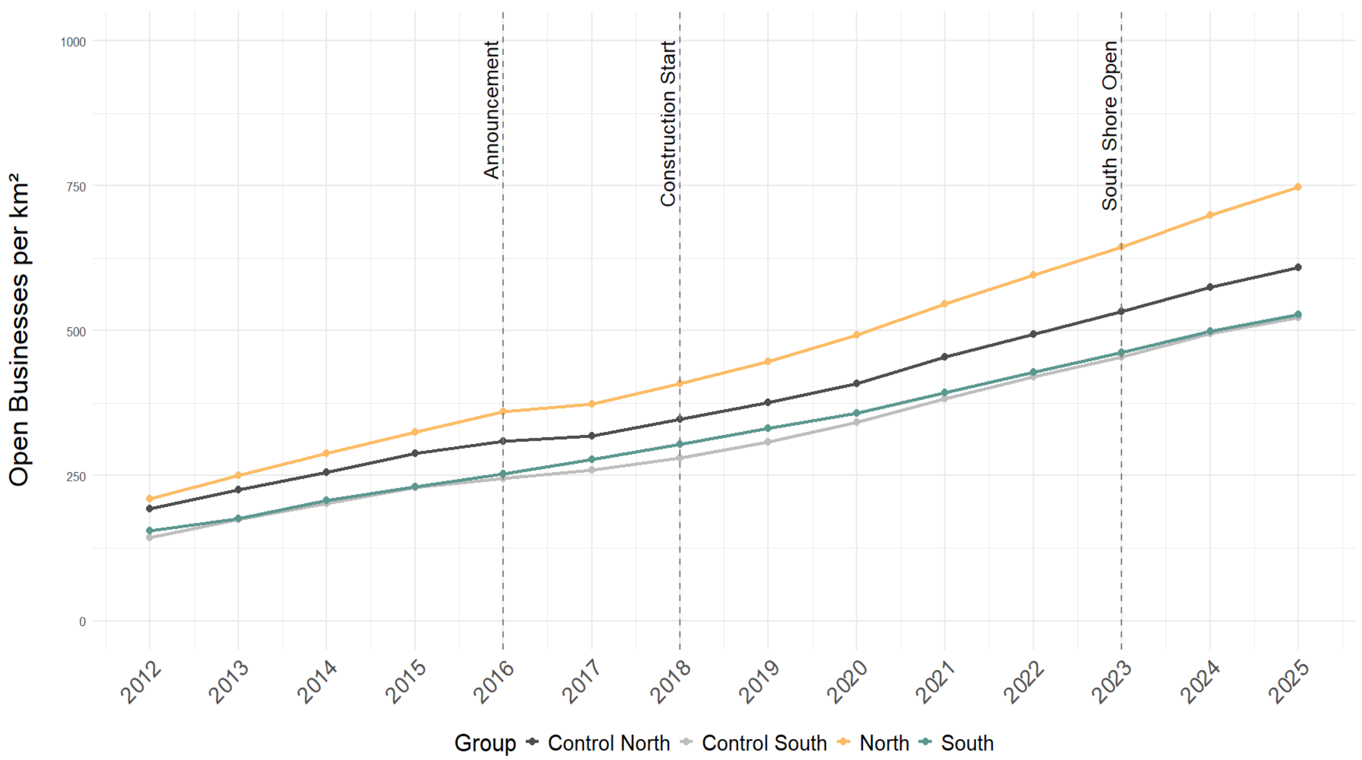


Figure 4. Open businesses per km² (501-1000 meters)

Results

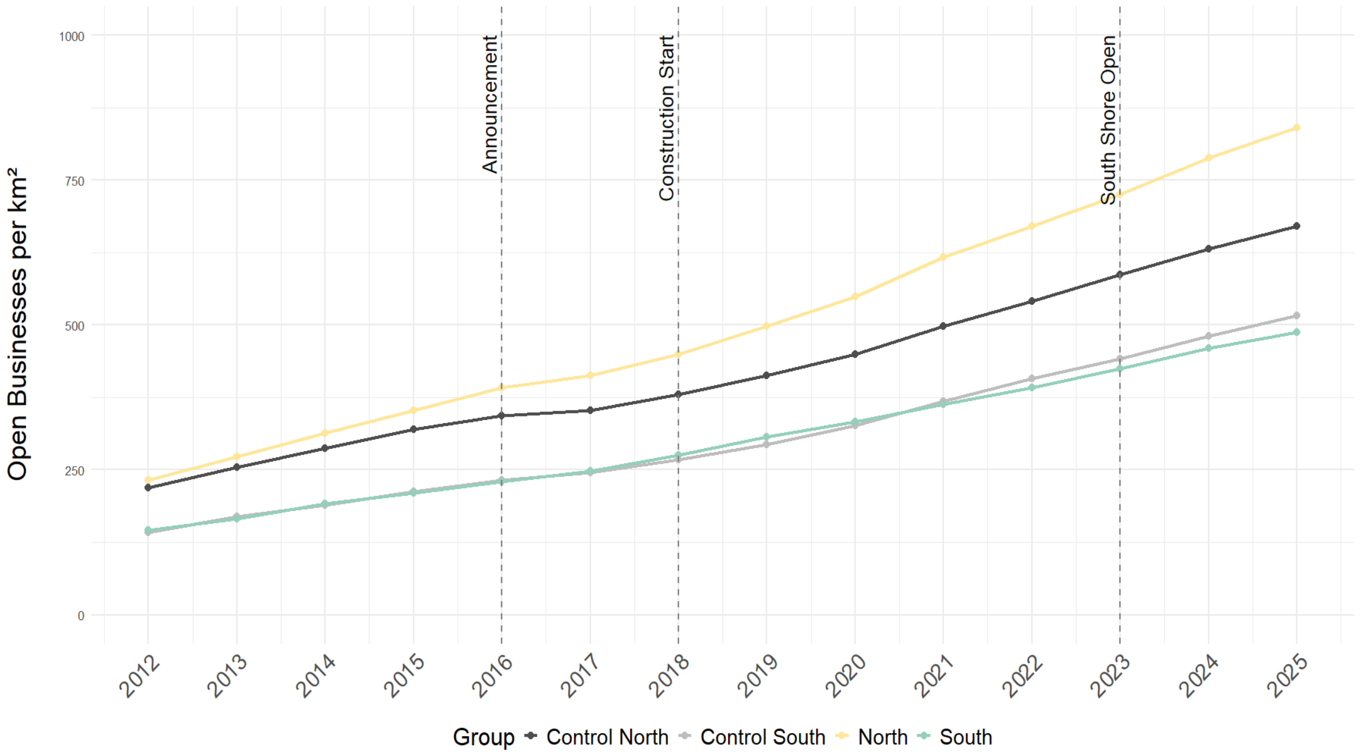


Figure 5. Open businesses per km² (1001-1500 meters)

Results

5.3 Natural Experiment Results

DiD model results are presented in Figures 6-11 (and Tables 4-9 in the appendix). Across the 18 models, population density is significant in 14, Can-ALEs' dwelling density index is significant in 12, and median income is significant in 10. All significant confounding variables are positive with the exception of median income, whose values are significant and negative in five models. All year-specific coefficients show significant and positive effects on business density except for 2016 and 2017 in the South Shore knowledge business model in the 500 meter buffer zone. The treated variable represents the REM's baseline difference on the density of businesses in catchment areas compared to the control without consideration of the temporal effects. This value is only significant in four of the 18 models.

5.3.1 Service Businesses

Based on the average treatment effect estimates, the REM did not lead to any statistically significant increases in service business density in the South Shore (Figure 6). These results may be due to the South Shore stations' location directly adjacent to highways and parking lots as well as a lack of coordinated zoning reforms and land use planning. The northern branches experience statistically significant service business density increases ranging from 16.06-19.16% in the 0-500 meter catchment area from 2021 onward (Figure 7). Statistically significant service business density increases of around 7-8% occur in the 1001-1500 meter catchment area in 2018, 2023, and 2025. Although several stations in the northern branches are also adjacent to car infrastructure, some are in proximity to areas with greater density and intensity of use which may partially explain why significant effects were observed along this portion of the REM. Statistically significant results during the construction phase indicate that the expectation of improved accessibility from the REM was enough to encourage service business growth along the northern branches. The decreasing magnitude of the REM's effects as distance increases aligns with previous research findings (Champagne et al., 2024; Chatman et al., 2016; Credit, 2018; Liu & Bardaka, 2023).

Results

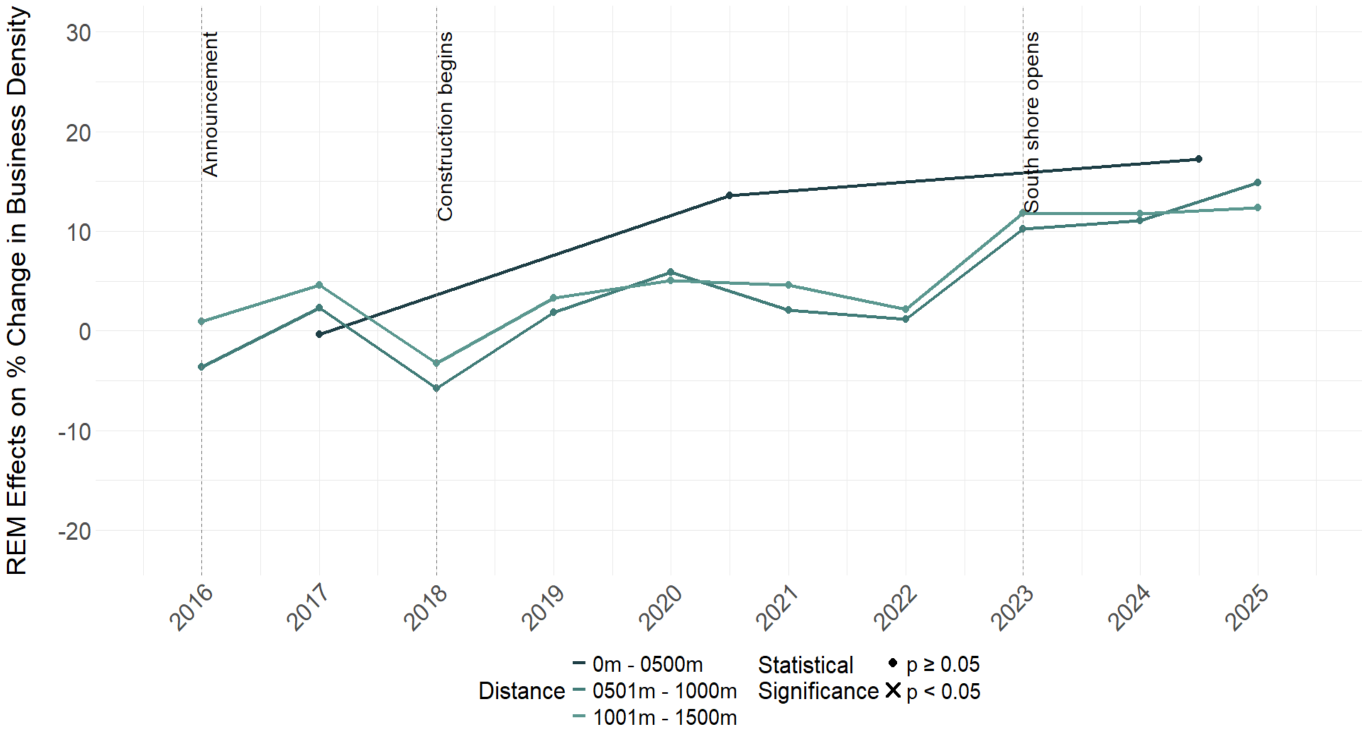


Figure 6. Impact of the REM on service business growth along the South Shore

Figure 7. Impact of the REM on service business growth along the northern branches

Results

5.3.2 Retail Businesses

Our results indicate that the REM did not have statistically significant effects on retail business density along the South Shore branch, as was the case for service businesses (Figure 8). In the northern branches, statistically significant retail density increases of 8.40-13.05% are estimated at 1001-1500 meters from 2017 onward, peaking in 2020 and 2023-2025, while the two closer catchment areas yield no significant effects (Figure 9). These results suggest a divergence between business types in their spatial response to transit. Unlike service businesses, retail density gains were concentrated further from stations and persisted across the announcement and construction phases rather than emerging only after construction began.

5.3.3 Knowledge Businesses

Within 501-1000 meters of South Shore stations, between the years 2022 and 2025, the REM is associated with statistically significant decreases in knowledge business density of 15.48% to 22.38% (Figure 10). Between 2021 and 2025, we observe statistically significant decreases of 12.41% to 19.65% within 1001-1500 meters of stations. In both catchment areas, the percent change in knowledge business density increases in magnitude after the inauguration of the REM. These results highlight the varying effects based on business type from transit projects and show that professional service and FIRE (finance, insurance, and real estate) business density was negatively impacted leading up to the opening and especially after the opening of the REM, at least around South Shore stations.

Conversely, knowledge business density in the northern branches experienced a statistically significant increase ranging from 13.60-15.59% in the smallest buffer zone between 2017 and 2020 (Figure 11). In the largest catchment area, however, knowledge business density declined significantly by approximately 5.51-8.05% between 2021 and 2025, suggesting a reversal of the earlier agglomeration effect. This may indicate that the announcement and early construction period of the REM incited knowledge businesses to locate near stations in anticipation of greater accessibility for workers and clients. This pattern may reflect a competitive displacement dynamic, whereby knowledge businesses further from stations were outcompeted by more centrally located knowledge businesses and by the retail and service activity emerging in the same corridor.

Results

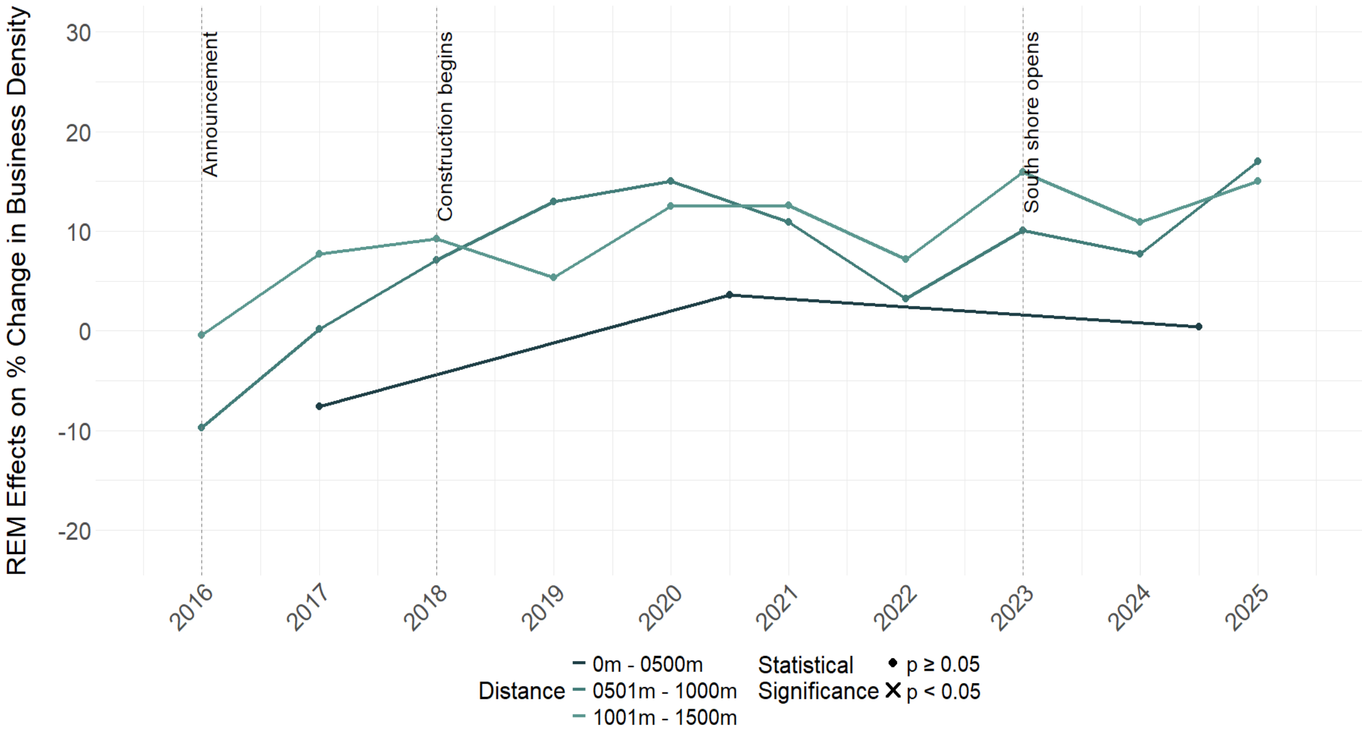


Figure 7. Impact of the REM on retail business growth along the South Shore

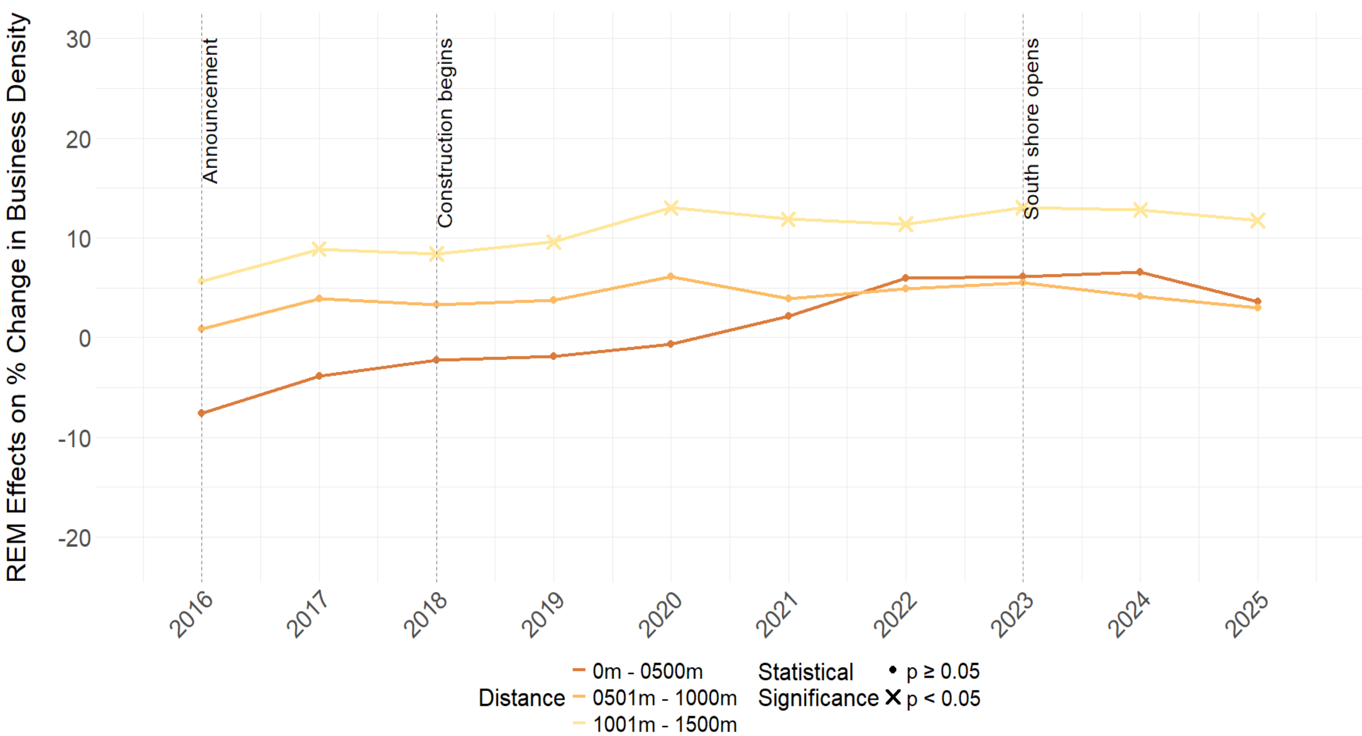


Figure 8. Impact of the REM on retail business growth along the northern branches

Results

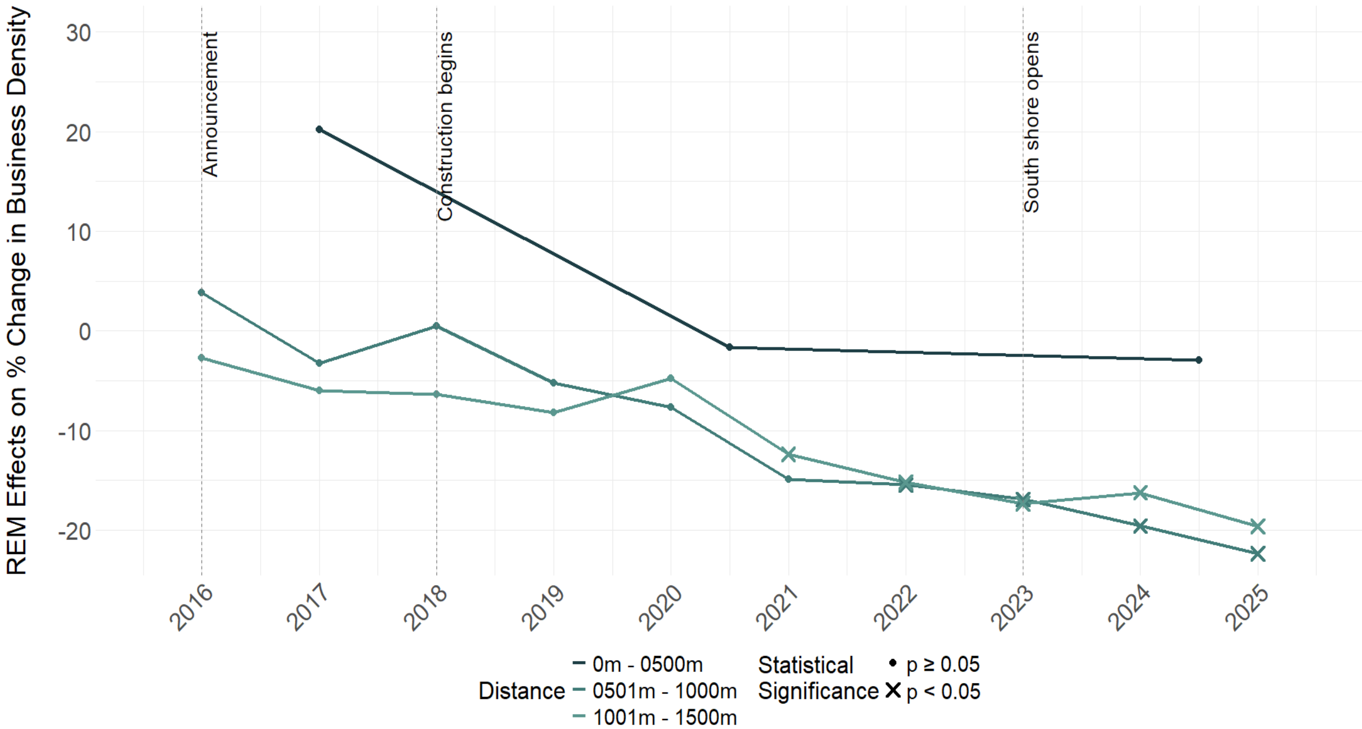


Figure 9. Impact of the REM on knowledge business growth along the South Shore

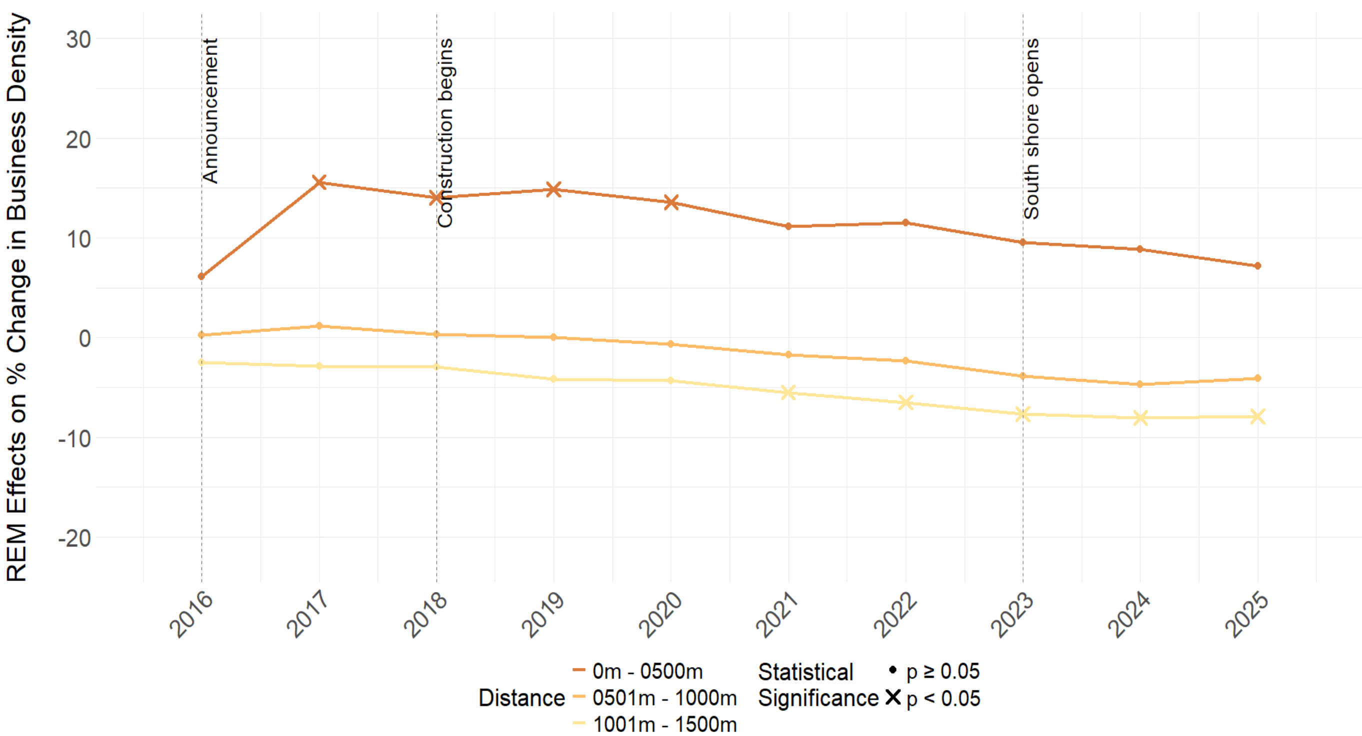


Figure 10. Impact of the REM on knowledge business growth along the northern branches

DISCUSSION

Discussion

Our results provide multiple insights into how the REM, and light rail infrastructure broadly, can influence businesses in a region. Our DiD framework confirms a causal relationship between light rail investment and statistically significant changes in service, retail, and knowledge business density within 1500 meters of stations, with the direction and magnitude varying by sector and distance. Consistent with prior findings, our results are generally of greater magnitude in closer proximity to stations, with decreasing effects as distance increases (Champagne et al., 2024; Chatman et al., 2016; Credit, 2018; Liu & Bardaka, 2023).

The results demonstrate that transit infrastructure projects can have positive effects on business density throughout all phases, depending on the business sector. Across the South Shore, the strongest effects occur once the REM is operational. The northern branches, which do not undergo an operational phase, experience the strongest effects during the latter portion of the construction phase. These trends illustrate that market anticipation can have statistically significant effects on business density. Previous research on phasing has been unsuccessful in finding a clear pattern between phases. While the operational phase produces the strongest effects in our study, existing research has attributed peak effects to each of the three phases across different contexts (Champagne et al., 2024; Liu & Bardaka, 2023, 2025). These mixed findings suggest that this trend may not be generalizable across different cities, projects, and economic sectors. There is a need for more nuanced research into the phase-based impacts of a transit project on businesses to better understand what factors may be at play.

Despite concerns regarding the disruptive effects of noise, pollution, and road closures, our results do not indicate statistically significant decreases in retail or service business density during construction of the REM. In fact, the REM led to statistically significant increases in business density for both sectors during the construction phase along the northern branches. On the other hand, knowledge businesses within 501 to 1500 meters do experience statistically significant decreases in density during the latter half of the construction. However, the persistence of knowledge business density declines after the start of operation in the South Shore suggests that construction disruption may not be the primary factor in business declines. This highlights the nuanced nature of business behavior and should prompt policymakers to develop targeted mitigation strategies for vulnerable firms. Nevertheless, our results can be used to assuage concerns, especially among service and retail business owners, who fear deleterious effects from the construction of new transit infrastructure.

POLICY IMPLICATIONS

Policy Implications

These results point to several key interventions that planners and policymakers can consider. Generally, findings show that to maximize benefits, land use planning must accompany transit investment. Across all sectors in the South Shore, none of the studied business sectors experience statistically significant increases in density. We attribute this, in part, to the placement of South Shore stations adjacent to highways and large parking lots. To maximize the local economic benefits from a project like the REM, stations should be constructed in areas where businesses can physically open. Further, although some municipalities have modified zoning by-laws to allow for more commercial density (Soliz et al., 2024), our results indicate that, in some cases, more planning or other incentives may be required to encourage business development.

Transit-oriented developments (TOD) that require ground floor commercial uses in residential buildings and that include programs to coordinate with commercial tenants could promote both economic benefits and increase REM ridership. Decision makers should also be conscious of the unequal effects on businesses across economic sectors. Our findings that the REM led to decreases in knowledge business density in the South Shore and in some areas around the northern branches should encourage municipalities to identify which firms are most vulnerable to transit-induced displacement. Our results for retail and service businesses indicate either no significance or significant growth. However, this growth should not be read as unequivocal evidence against displacement since aggregate density increases do not preclude individual businesses closing even as new ones open. This work, and additional work on business closures specifically, could inform targeted support mechanisms, such as financial assistance or facilitated relocation for vulnerable firms.

CONCLUSION

Conclusion

This study investigates the impacts of Montréal's new light rail project (the REM) on service and retail business density during the project's announcement, construction, and operation phases along the South Shore branch and the northern branches. Using data from 89,616 businesses in the Montréal CMA across 14 years, we apply a DiD approach to isolate the REM's effect on business density within 1,500 meters of stations. Our findings show that the REM is associated with increases in service and retail business density, especially during the operational phase and during the end of the construction phase. Knowledge businesses experience increases and decreases depending on the branch and distance from stations. Potentially due to unaccommodating land uses such as parking lots and highways, our results do not generally show statistical significance within 500 meters of stations.

Due to the recent opening of the REM in the South Shore and the fact that none of the northern branches have been open for at least one year, our study has limited ability to assess the REM's effects on businesses during the operation phase. Similar studies indicate that businesses may be affected differently during the short-term, medium-term, and long-term of the operation phase (Liu & Bardaka, 2023, 2025). Future research can examine the REM's impact on businesses after the entire network has been operating for several years and investigate how zoning changes mediate the REM's impact on business density.

Appendix

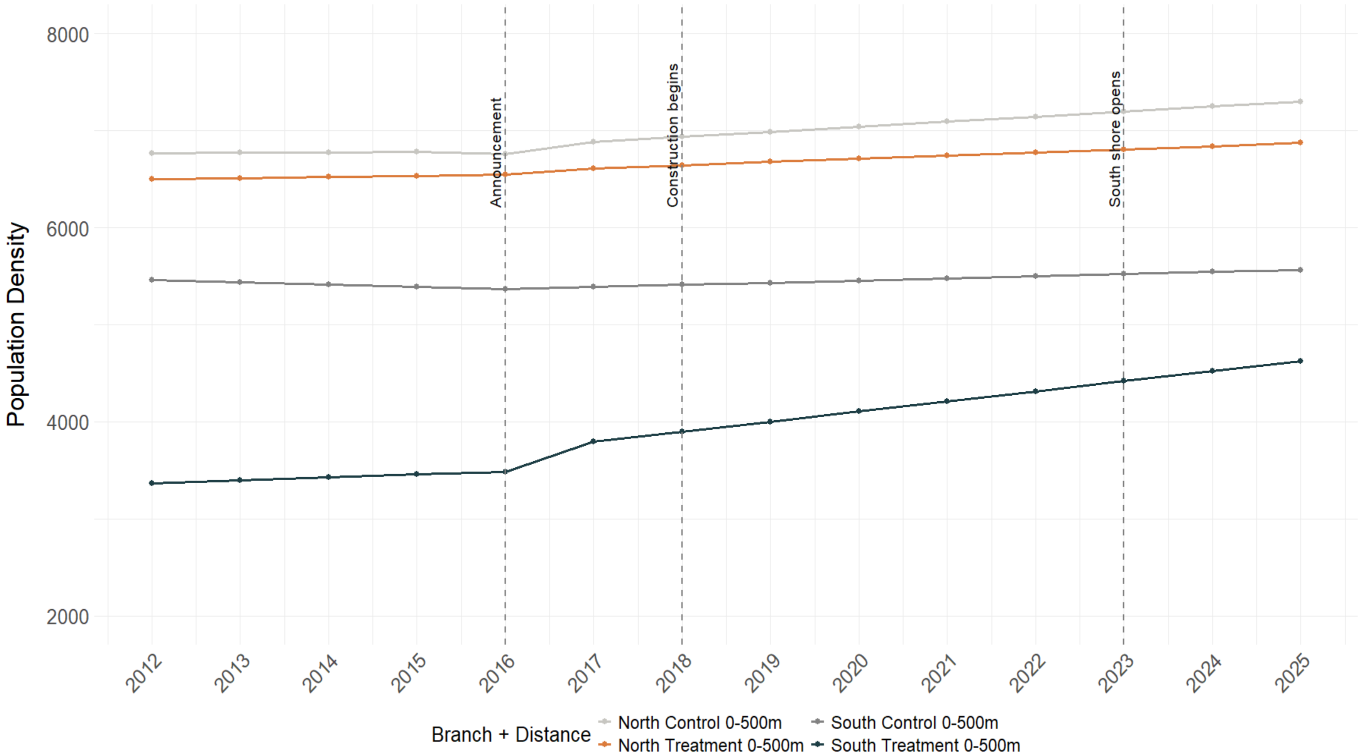


Figure 12. Population density by year and branch in the 0-500 meter catchment area

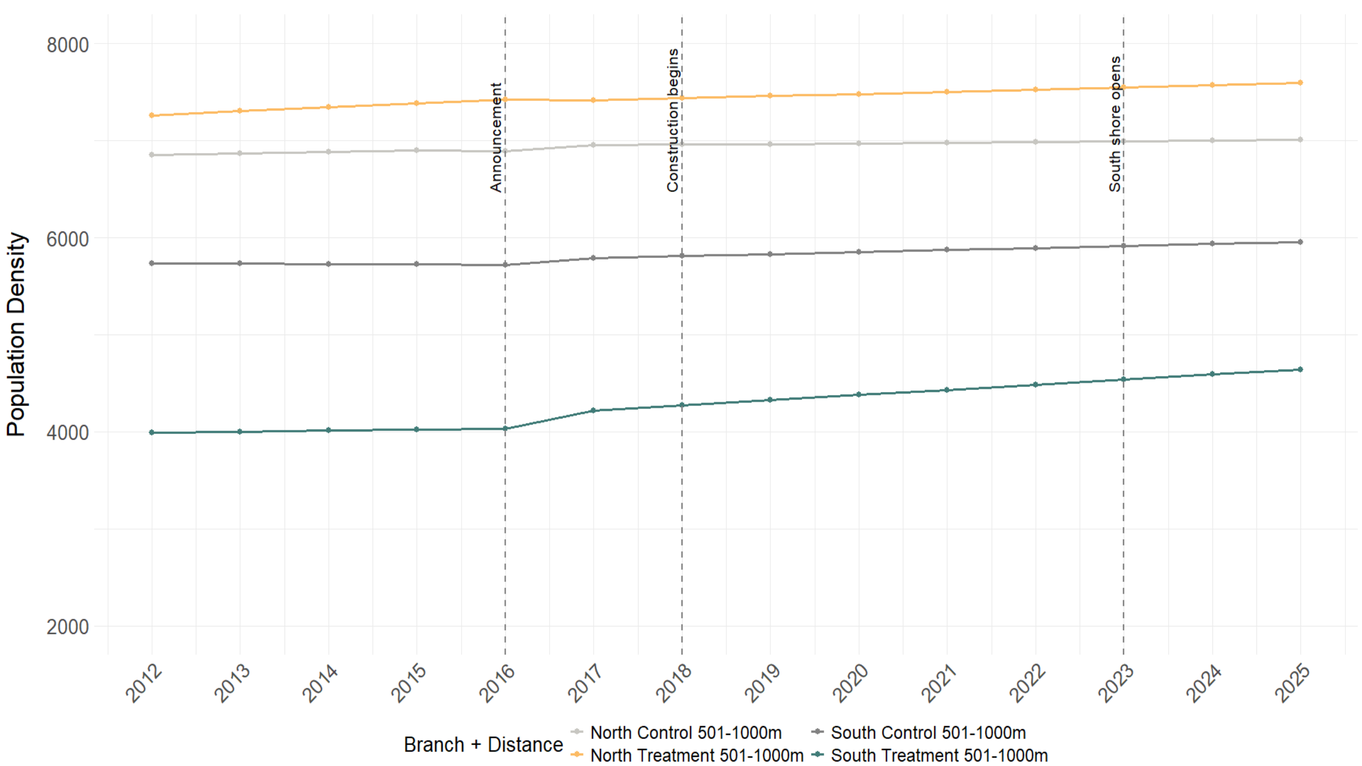


Figure 13. Population density by year and branch in the 501-1000 meter catchment area

Appendix

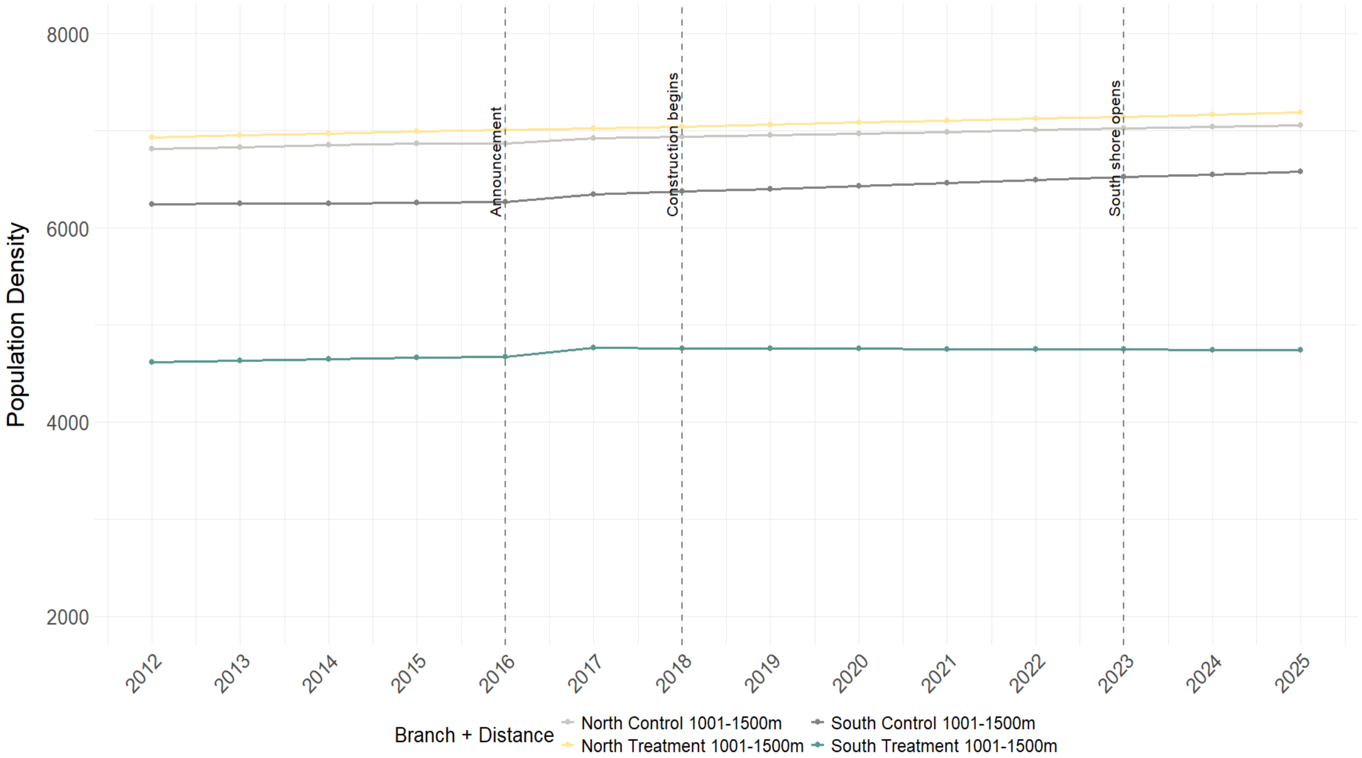


Figure 14. Population density by year and branch in the 1001-1500 meter catchment area

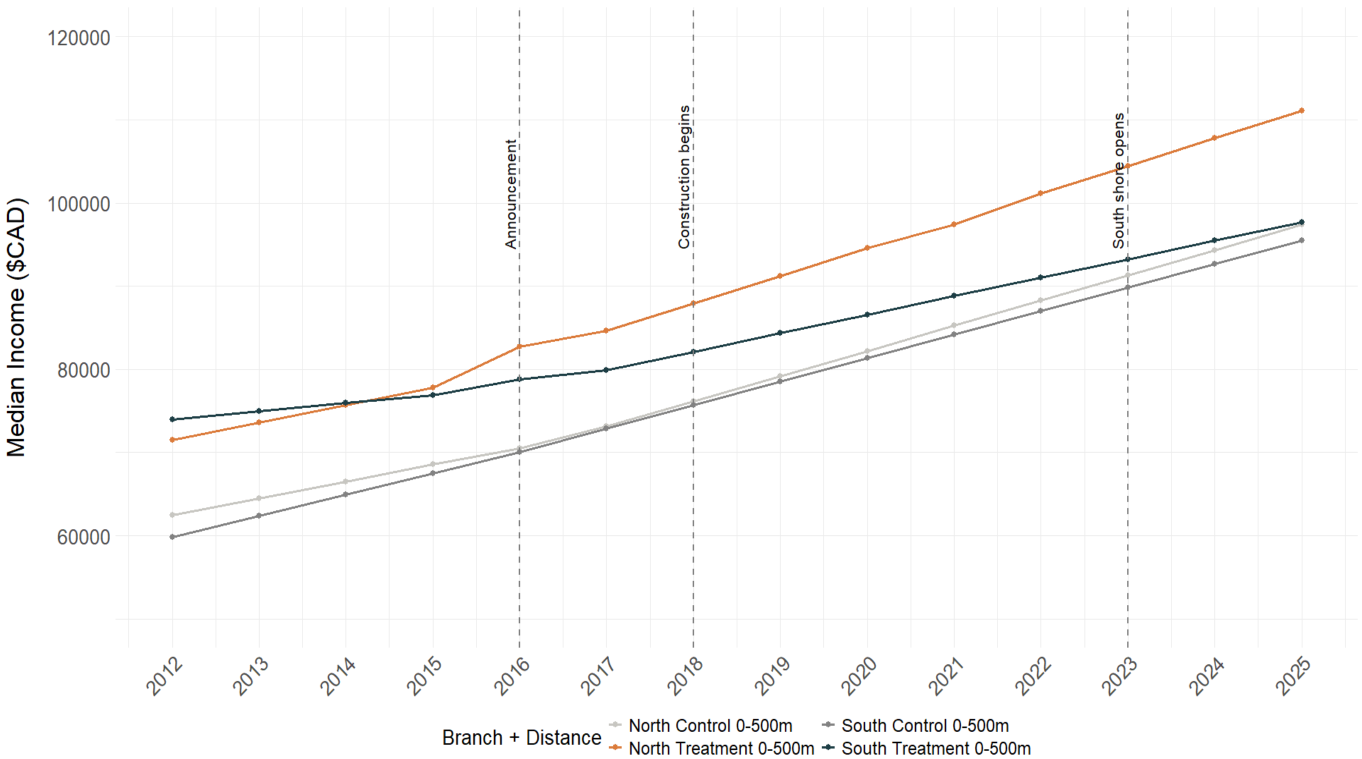


Figure 15. Median income by year and branch in the 0-500 meter catchment area

Appendix

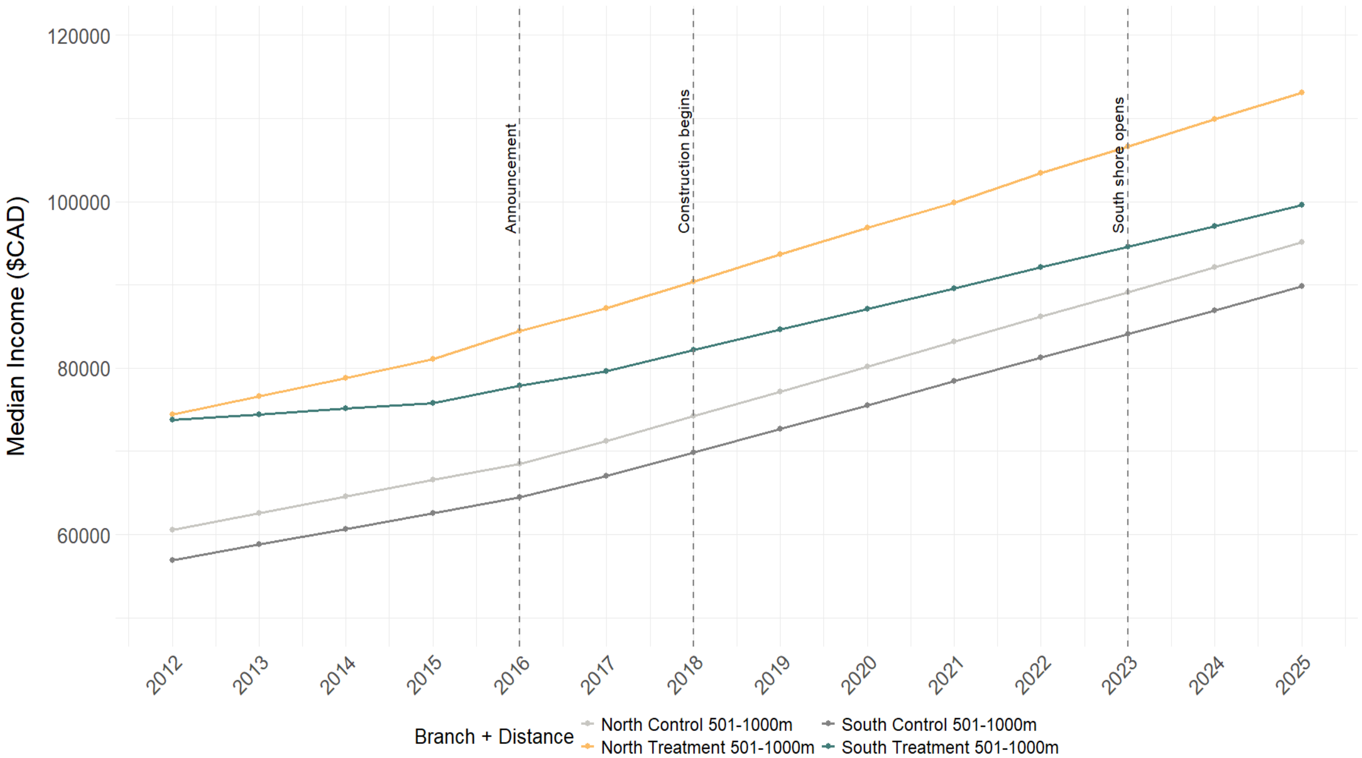


Figure 16. Median income by year and branch in the 501-1000 meter catchment area

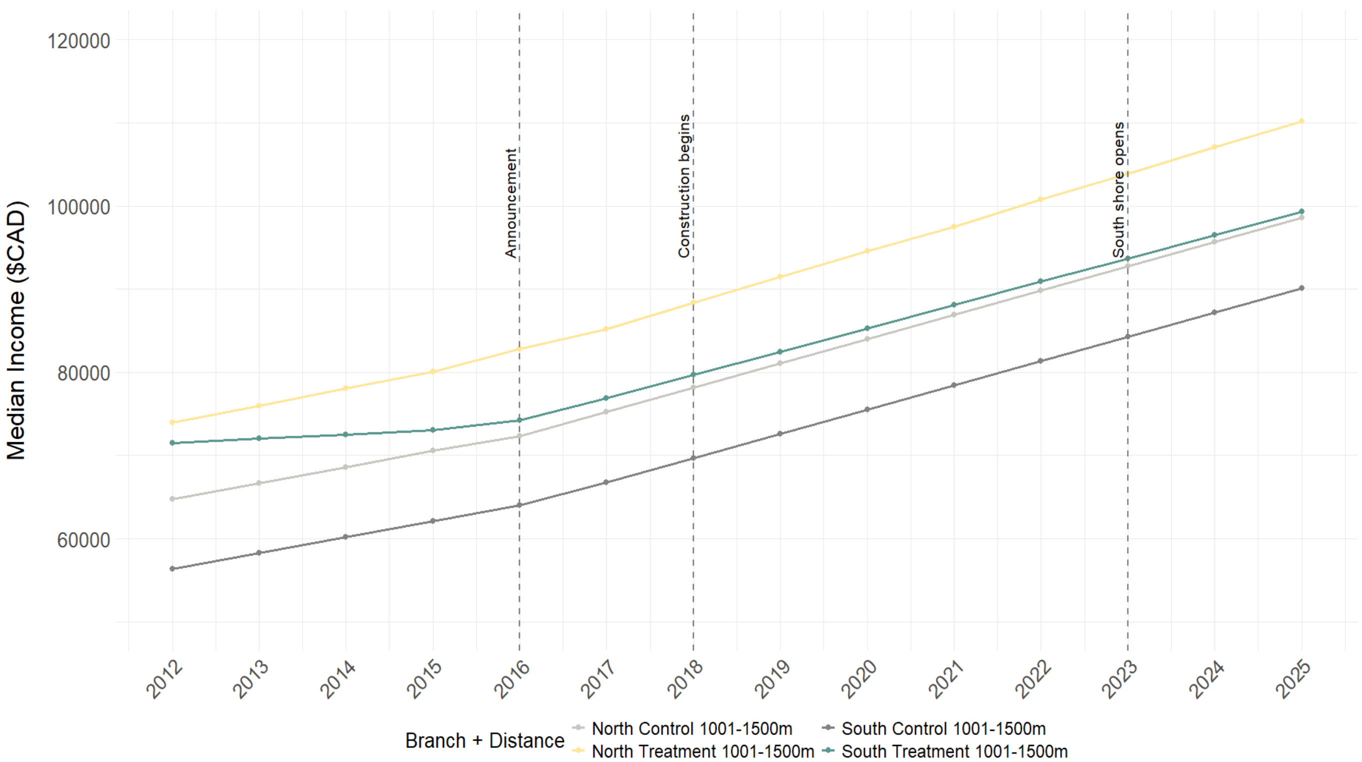


Figure 17. Median income by year and branch in the 1001-1500 meter catchment area

Appendix

Service	Retail	Knowledge
Accommodation	Food, Drink, Medicine, and Tabaco Retail	Credit Societies
Entertainment and Leisure Services	Shoes, Clothing, and Fabric Retail	Investment Businesses
Personal and Domestic Services	Home Furnishings Retail	Insurance Businesses
	Automobile (Parts and Accessories) Retail	Financial Intermediaries
		Real Estate Services
		Insurance and Real Estate Agencies
		IT, Accounting, Advertising Services
		Architecture, Engineering, and Technical Services
		Law and Notary Services

Table 2. Business Sectors

0-500 metres

	South Shore Branch		Northern Branches	
	Control	Treated	Control	Treated
2018	1.350	0.094	0.825	0.386

501-1000 metres

	South Shore Branch		Northern Branches	
	Control	Treated	Control	Treated
2018	1.322	0.302	0.927	0.688

1001-1500 metres

	South Shore Branch		Northern Branches	
	Control	Treated	Control	Treated
2018	1.240	0.370	0.918	0.745

Table 3. Can-ALE dwelling count z-scores by branch and catchment area

Appendix

	0-500m	501-1000m	1001-1500m
Intercept	21.76	389.49	513.68 **
Treated (South)	171.37	16.08	22.53
Year Effects			
2016 [Announcement]	52.04 **	51.24 ***	45.78 ***
2017 [Announcement]		54.81 ***	46.61 ***
2018 [Construction]		78.07 ***	62.68 ***
2019 [Construction]		79.59 ***	72.48 ***
2020 [Construction]	77.77 ***	81.01 ***	78.16 ***
2021 [Construction]		102.93 ***	92.00 ***
2022 [Construction]		108.24 ***	105.48 ***
2023 [Operation]		116.24 ***	110.90 ***
2024 [Operation]	105.46 ***	133.38 ***	133.03 ***
2025 [Operation]		142.69 ***	148.51 ***
Confounding Variables			
CanALE Walkability	64.84	40.35 *	35.89 **
Population (000s/km²)	22.25 **	7.56 *	6.11 ***
Median Income ($10,000)	12.34 **	4.96	1.32
Treated x Year Effects			
South x 2016 [Ann.]	-0.38	-3.61	0.93
South x 2017 [Ann.]		2.30	4.59
South x 2018 [Constr.]		-5.75	-3.24
South x 2019 [Constr.]		1.82	3.27
South x 2020 [Constr.]	13.55	5.90	5.02
South x 2021 [Constr.]		2.05	4.59
South x 2022 [Constr.]		1.13	2.13
South x 2023 [Op.]		10.23	11.82
South x 2024 [Op.]	17.22	11.09	11.77
South x 2025 [Op.]		14.90	12.37
Random Effects			
σ2	1055.75	928.79	912.92
τ00 (DAs)	8802.64	6446.5	5843.03
ICC	0.89	0.87	0.86
N (DAs)	22	46	83
Observations	211	646	1324
Marginal/Conditional R^2	0.357 / 0.931	0.250 / 0.906	0.232 / 0.896

Table 4. REM Effects on service business density in the South Shore

Appendix

	0-500m	501-1000m	1001-1500m
Intercept	198.94 ***	209.23 ***	194.50 ***
Treated (North)	-47.93 **	-15.65	-9.25
Year Effects			
2016 [Announcement]	37.67 ***	36.29 ***	36.75 ***
2017 [Announcement]	41.06 ***	40.19 ***	40.35 ***
2018 [Construction]	49.47 ***	47.85 ***	46.27 ***
2019 [Construction]	58.28 ***	57.89 ***	59.04 ***
2020 [Construction]	70.05 ***	67.58 ***	68.57 ***
2021 [Construction]	78.37 ***	83.73 ***	81.54 ***
2022 [Construction]	92.65 ***	98.28 ***	94.60 ***
2023 [Construction]	106.80 ***	112.51 ***	108.99 ***
2024 [Construction]	124.84 ***	134.01 ***	125.38 ***
2025 [Construction]	142.98 ***	150.13 ***	139.67 ***
Confounding Variables			
CanALE Walkability	55.18 ***	53.79 ***	80.85 ***
Population (000s/km²)	5.92 ***	6.11 ***	3.90 ***
Median Income ($10,000)	-0.85	-1.94 **	0.34
Treated x Year Effects			
North x 2016 [Ann.]	1.65	-1.48	0.59
North x 2017 [Ann.]	9.90	5.41	4.97
North x 2018 [Constr.]	11.18	5.81	8.06 *
North x 2019 [Constr.]	14.48	4.68	4.32
North x 2020 [Constr.]	13.94	5.02	3.96
North x 2021 [Constr.]	16.21 *	3.59	4.62
North x 2022 [Constr.]	16.06 *	1.63	4.28
North x 2023 [Constr.]	18.68 *	5.37	7.07 *
North x 2024 [Constr.]	16.09 *	2.04	5.81
North x 2025 [Constr.]	19.16 *	3.55	7.15 *
Random Effects			
σ2	901.69	991.74	1000.34
τ00 (DAs)	8013.24	7146.74	7469.49
ICC	0.9	0.88	0.89
N (DAs)	198	509	835
Observations	1948	5094	8223
Marginal/Conditional R^2	0.455/ 0.945	0.463 / 0.935	0.534 / 0.945

Table 5. REM Effects on service business density in the northern branches

Appendix

	0-500m	501-1000m	1001-1500m
Intercept	915.74 ***	1141.12 ***	969.85 ***
Treated (South)	89.06	-4.51	2.61
Year Effects			
2016 [Announcement]	47.27 ***	35.49 ***	35.34 ***
2017 [Announcement]		46.01 ***	42.45 ***
2018 [Construction]		43.02 ***	50.56 ***
2019 [Construction]		47.91 ***	65.42 ***
2020 [Construction]	61.28 ***	55.67 ***	73.92 ***
2021 [Construction]		72.13 ***	85.99 ***
2022 [Construction]		89.99 ***	104.07 ***
2023 [Operation]		106.20 ***	120.27 ***
2024 [Operation]	88.46 ***	128.39 ***	145.81 ***
2025 [Operation]		132.89 ***	153.27 ***
Confounding Variables			
CanALE Walkability	140.82	23.60	7.67
Population (000s/km²)	-4.64	7.59 *	9.08 ***
Median Income ($10,000)	0.43	-3.17	-3.72 *
Treated x Year Effects			
South x 2016 [Ann.]	-7.61	-9.74	-0.45
South x 2017 [Ann.]		0.14	7.71
South x 2018 [Constr.]		7.14	9.22
South x 2019 [Constr.]		12.99	5.33
South x 2020 [Constr.]	3.64	15.04	12.55
South x 2021 [Constr.]		10.89	12.61
South x 2022 [Constr.]		3.24	7.18
South x 2023 [Op.]		10.06	15.95
South x 2024 [Op.]	0.41	7.72	10.94
South x 2025 [Op.]		17.03	15.00
Random Effects			
σ2	677.78	854.41	967.08
τ00 (DAs)	10860.5	6391.73	5176.66
ICC	0.94	0.88	0.84
N (DAs)	19	66	143
Observations	200	644	1411
Marginal/Conditional R^2	0.156 / 0.950	0.193 / 0.905	0.248 / 0.882

Table 6. REM Effects on retail business density in the South Shore

Appendix

	0-500m	501-1000m	1001-1500m
Intercept	1107.09 ***	1076.23 ***	1010.28 ***
Treated (North)	-19.77	-12.35	-3.68
Year Effects			
2016 [Announcement]	31.96 ***	24.21 ***	20.90 ***
2017 [Announcement]	27.24 ***	21.98 ***	18.66 ***
2018 [Construction]	32.01 ***	28.80 ***	24.71 ***
2019 [Construction]	37.44 ***	35.66 ***	31.94 ***
2020 [Construction]	44.89 ***	45.86 ***	38.90 ***
2021 [Construction]	56.89 ***	62.21 ***	54.79 ***
2022 [Construction]	70.03 ***	74.46 ***	66.20 ***
2023 [Construction]	80.02 ***	86.23 ***	77.32 ***
2024 [Construction]	93.40 ***	102.10 ***	91.29 ***
2025 [Construction]	105.50 ***	115.37 ***	102.47 ***
Confounding Variables			
CanALE Walkability	63.66 ***	43.81 ***	54.47 ***
Population (000s/km²)	0.34	4.38 ***	3.95 ***
Median Income ($10,000)	-0.93	-1.94 **	-1.41 **
Treated x Year Effects			
North x 2016 [Ann.]	-7.58	0.87	5.65
North x 2017 [Ann.]	-3.88	3.93	8.89 *
North x 2018 [Constr.]	-2.29	3.29	8.40 *
North x 2019 [Constr.]	-1.86	3.73	9.59 **
North x 2020 [Constr.]	-0.64	6.13	13.02 ***
North x 2021 [Constr.]	2.17	3.87	11.87 **
North x 2022 [Constr.]	5.97	4.88	11.38 **
North x 2023 [Constr.]	6.10	5.49	13.05 ***
North x 2024 [Constr.]	6.57	4.11	12.82 ***
North x 2025 [Constr.]	3.56	3.01	11.76 **
Random Effects			
σ^2	999.98	959.47	1043.83
τ_{00} (DAs)	9234.64	8134.12	6960.64
ICC	0.9	0.89	0.87
N (DAs)	200	515	841
Observations	1957	5125	8475
Marginal/Conditional R^2	0.264 / 0.928	0.331 / 0.929	0.443 / 0.927

Table 7. REM Effects on retail business density in the northern branches

Appendix

	0-500m	501-1000m	1001-1500m
Intercept	345.89 **	1591.67 ***	1428.39 ***
Treated (South)	141.79	67.93 *	56.52 **
Year Effects			
2016 [Announcement]	13.24	25.48 ***	31.72 ***
2017 [Announcement]		37.40 ***	41.18 ***
2018 [Construction]		48.30 ***	55.38 ***
2019 [Construction]		69.00 ***	74.00 ***
2020 [Construction]	60.26 ***	82.52 ***	82.34 ***
2021 [Construction]		119.24 ***	111.98 ***
2022 [Construction]		146.50 ***	138.26 ***
2023 [Operation]		170.91 ***	164.67 ***
2024 [Operation]	103.64 ***	197.49 ***	183.32 ***
2025 [Operation]		221.43 ***	203.89 ***
Confounding Variables			
CanALE Walkability	21.84	29.16	28.18 *
Population (000s/km²)	20.61 **	4.85	5.14 ***
Median Income ($10,000)	14.29 ***	4.14 *	4.90 ***
Treated x Year Effects			
South x 2016 [Ann.]	20.19	3.80	-2.71
South x 2017 [Ann.]		-3.25	-5.98
South x 2018 [Constr.]		0.51	-6.35
South x 2019 [Constr.]		-5.25	-8.19
South x 2020 [Constr.]	-1.65	-7.67	-4.79
South x 2021 [Constr.]		-14.94	-12.41 *
South x 2022 [Constr.]		-15.48 *	-15.23 **
South x 2023 [Op.]		-16.93 *	-17.34 **
South x 2024 [Op.]	-2.92	-19.58 *	-16.25 **
South x 2025 [Op.]		-22.38 **	-19.65 ***
Random Effects			
σ2	691.35	600.47	589.88
τ00 (DAs)	7781.33	7450.02	5748.12
ICC	0.92	0.93	0.91
N (DAs)	22	71	155
Observations	228	736	1618
Marginal/Conditional R^2	0.354 / 0.947	0.204 / 0.941	0.256 / 0.931

Table 8. REM Effects on knowledge business density in the South Shore

Appendix

	0-500m		501-1000m		1001-1500m	
Intercept	1856.61	***	1509.97	***	1459.58	***
Treated (North)	-14.70		15.72		25.27	***
Year Effects						
2016 [Announcement]	27.90	***	34.96	***	36.08	***
2017 [Announcement]	30.40	***	40.13	***	43.26	***
2018 [Construction]	43.88	***	55.71	***	55.99	***
2019 [Construction]	60.93	***	71.16	***	70.95	***
2020 [Construction]	78.09	***	88.95	***	89.21	***
2021 [Construction]	98.73	***	112.87	***	114.38	***
2022 [Construction]	117.54	***	134.90	***	136.98	***
2023 [Construction]	136.91	***	157.74	***	160.49	***
2024 [Construction]	154.80	***	179.74	***	182.13	***
2025 [Construction]	170.20	***	195.41	***	197.04	***
Confounding Variables						
CanALE Walkability	68.96	***	46.40	***	56.89	***
Population (000s/km²)	0.65		4.34	***	3.44	***
Median Income ($10,000)	3.94	***	3.89	***	4.66	***
Treated x Year Effects						
North x 2016 [Ann.]	6.12		0.24		-2.48	
North x 2017 [Ann.]	15.59	*	1.16		-2.86	
North x 2018 [Constr.]	14.05	*	0.35		-2.92	
North x 2019 [Constr.]	14.87	*	0.04		-4.18	
North x 2020 [Constr.]	13.60	*	-0.69		-4.32	
North x 2021 [Constr.]	11.17		-1.70		-5.51	*
North x 2022 [Constr.]	11.54		-2.35		-6.51	**
North x 2023 [Constr.]	9.52		-3.86		-7.67	**
North x 2024 [Constr.]	8.89		-4.73		-8.05	**
North x 2025 [Constr.]	7.18		-4.09		-7.90	**
Random Effects						
σ2	606.51		643.15		660.65	
τ00 (DAs)	6843.02		6436.08		5866.72	
ICC	0.92		0.91		0.9	
N (DAs)	206		528		872	
Observations	2171		5629		9298	
Marginal/Conditional R^2	0.371 / 0.949		0.393 / 0.945		0.476 / 0.947	

Table 9. REM Effects on knowledge business density in the northern branches

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