Moving Opportunity Closer:

How Public Transit Transforms Firm Composition and Employment

Akhila Kovvuri*[1] and Karmini Sharma[2]

[1]Stanford University

[2]Imperial College London

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Abstract

Transportation infrastructure can improve workers' access to existing economic opportunities, but it can also reshape economic opportunity itself by influencing where and what kinds of firms locate. This paper studies how public transit infrastructure influences firm location, composition, and employment using novel neighborhood-level data and multiple empirical strategies exploiting the phased expansion of the Delhi Metro Rail in India. Transit access increases economic dynamism, with more and larger firms entering near transit stations. This creates new economic hubs, with larger retail and service firms driven by greater footfall near transit stations. Employment increases, especially of women—a crucial effect in a context with low female labor force participation. Counterfactual decompositions show that changing firm size and industry composition explain more of this gendered effect, as firms that ex-ante hire more women are also more likely to move in closer to transit stations. Understanding how infrastructure reshapes the demand side of the labor market is thus critical for predicting and enhancing its distributional impacts.

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1 Introduction

In rapidly urbanizing cities across the world, governments are investing trillions in public transit infrastructure. While transit can improve workers' access to existing economic opportunities, it can also reshape economic opportunity itself by influencing where and what kinds of firms locate. Transit-induced changes in connectivity may centralize economic activity in established centers or redistribute it to newly connected peripheral areas. Firms and industries differ in their location incentives—some value access to labor markets, others prioritize proximity to consumers or lower rents—such that infrastructure investments may alter the composition of local employment opportunities. This raises two open questions. First, how do transit-driven changes in firm location affect the spatial distribution of employment? Second, since workers differ both in their commute sensitivity and their propensity to work in particular firm types and industries, how do changes in firm composition translate into heterogeneous employment effects across worker groups?

This paper studies how public transit infrastructure influences firm location, composition, and employment, leveraging novel neighborhood-level data and the phased expansion of the Delhi Metro Rail in India. We construct the first spatially granular dataset of establishment stocks and flows for Delhi to study localized effects of new transit stations. To address location endogeneity and network effects inherent in transit infrastructure, we employ multiple differences-in-differences strategies—including comparisons against planned but never- or not-yet-built stations—as well as market access measures that capture citywide network connectivity changes. We combine these approaches with counterfactual decompositions that separate transit's effects on employment from change in mobility versus change in firm composition. To our knowledge, this provides the first comprehensive evidence on how intracity transit reshapes local firm composition and generates heterogeneous employment outcomes, underscoring that firm heterogeneity and boundaries are critical for understanding the distributional impacts of transit infrastructure.

Our findings reveal that transit access induces firm entry and reshapes the composition of local economic activity. Transit increases economic dynamism—triggering entry of larger, more specialized establishments, which in turn increases employment absorbed by new entrants in adjacent neighborhoods. The key incentive for firm entry appears to be access to consumers: of the 9 additional firms entering per neighborhood in a 6-month period, 7 are in retail or services, consistent with observed increases in foot traffic following station openings measured using mobile phone location data. These changes in the number and composition of entries translate into increased employment and the creation of new economic hubs around stations—with 177 additional workers per 100 residents—suggesting transformation from more residential areas. Notably, we find greater increases in female employment—28 of these additional workers are women, a large increase given low baseline labor force participation rates in this context. This seems to be driven by compositional shifts toward the types of firms—larger establishments and consumer-facing businesses—that ex-ante employ more women. Counterfactual decompositions confirm that changing firm size and industry composition—rather than improved mobility alone—accounts for most of the differential employment effects. This finding has important policy implications: interventions focused solely on reducing women's commuting costs—such as travel subsidies or women-only transport services—may increase mobility but generate limited employment gains if they do not also create jobs in establishments that are more likely to hire women. Understanding how infrastructure reshapes the demand side of the labor market is thus critical for predicting and enhancing its distributional impacts.

To study the intra-city effects of transit access, we construct the first spatially granular dataset of the stock of establishments and flow of establishment registrations for Delhi. Through a combination of secondary dataset harmonization, matching algorithms, and scraping, cleaning, and geocoding of administrative sources, we assemble a repeated cross-section of formal and informal establishments from the Economic Census (1990, 2005, and 2013) covering 500 wards[1], and the flow of new firm registrations (2011-2024) covering around 1,500 neighborhoods. This database extends beyond the district-level analyses that are typically feasible for firm analyses in Indian cities, increasing the spatial resolution 100-fold.[2]

Through these rich spatial data, we identify two key facts that motivate us to study the

[1] An urban electoral ward or a rural village, spatially similar to an electoral precinct in the United States

[2] Prior studies of firms in India use district-level data from Annual Surveys of Industries or National Sample Surveys (Topalova, 2010; Martin et al., 2017). Asher et al. (2021) enables spatially granular village-level analyses in rural areas (Asher and Novosad, 2020), but intra-city analysis of firms remains data constrained, with Gechter and Tsivanidis (2023) providing a notable exception for Mumbai, India.

effect of transit access on the location and composition of firm activity. First, employment rates of residents increase in wards closer to transit stations, especially in the urban periphery (5+ miles from the city center) and particularly for women, aligning with prior work on transit and female employment (Martinez et al., 2020; Kwon and Lee, 2024; Seki and Yamada, 2025). This is congruent with the theory that improved commuting technology could enable peripheral residents to access employment opportunities in the city center. However, we also observe a second pattern: increased firm entry concentrated around transit stations, rapidly decaying with distance from the stations. This suggests a change in the density of local economic activity in these neighborhoods. In a city where the majority of workers commute less than a mile for work, it is very possible that changes in jobs in one's own neighborhood have an influence on employment decisions.

To isolate the causal effect of transit access on firm entry and employment, we exploit the staggered rollout of Delhi's transit system using two complementary identification strategies tailored to our firm datasets. While planning began in the 1980s and the first line became operational in 2002, final station locations and construction timing depended on engineering constraints, funding availability, and land acquisition challenges—factors plausibly orthogonal to future firm location decisions. For firm entry analysis, we leverage Phase 3 expansions (2011-2024), which deviated from plans and built along major roadways to minimize costs and disturbance. We implement a staggered difference-in-differences design (Callaway and Sant'Anna, 2021), comparing areas within 1 kilometer of new stations to comparison areas also along major roadways but further from stations, with treatment beginning two years before operational opening to capture anticipatory effects during testing. We verify robustness using alternative comparison groups, varying distance buffers, and comparisons to never- or not-yet-built stations from a 2002 master plan. For firm composition and employment, we use census data (1990, 2005, 2013) to study earlier Phase 2 expansions (2005-2011), comparing areas treated during this period to not-yet-treated areas where stations were constructed after 2013—many of which were originally planned for simultaneous or earlier construction. Parallel trends hold across all specifications, and the temporal granularity of our firm entry data—with exact business commencement dates—enables us to precisely identify responses to station openings.

To capture transit effects beyond localized station areas, we employ two complementary spatial approaches. First, we construct market access measures following Donaldson and Hornbeck (2016) and Tsivanidis (2023) to account for broader connectivity gains across the entire network—particularly important given spatial spillovers inherent in transit systems. We include falsification tests to check that it is changing market access and not endogeneity of placement that is driving the employment effects (Borusyak and Hull, 2023). Second, to quantify the relative importance of firm composition changes versus improved mobility in explaining employment effects, we implement counterfactual decompositions using a gravity-based commuting framework (Ahlfeldt et al., 2015).

We first test whether the spatial correlation between transit stations and new firm registrations reflects a causal effect of transit infrastructure. New firm location decisions reveal the types of establishments drawn to transit access—a first step for understanding how the transit reshapes local economic composition, particularly in contexts like India where growth comes primarily from firm entry (Hsieh and Klenow, 2014; Akcigit et al., 2021; Chatterjee et al., 2025). We find that transit station openings cause an immediate, significant, and persistent increase in firm entry, with 9 additional firms entering in a neighborhood in a 6 month period, compared to the typical entry of 6 firms in comparable areas. The impact decays with distance from stations, with positive spillovers extending 1-2 kilometers. Entrants near transit stations are larger and more specialized, and the increase in firm entry is almost entirely driven by business-to-consumer establishments, with 7 out of the 9 new firms being in retail or services servicing consumers directly. Thus, access to consumers seems to be the primary incentive for firms to locate near transit stations. This is consistent with the increase in foot traffic that we see around opening of new stations, using data from mobile phone pings, as well as the lack of response from business-to-business firms, whether they hire high- or low- skill labor. This pattern aligns with evidence that firms place high value on locations with greater consumer traffic (Miyauchi et al., 2021; Bassi et al., 2022; Oh and Seo, 2023; Vitali, 2023). There is suggestive evidence that larger and more established brands enter first, and less established firms might follow to gain from the customer access spillovers, thus creating local hubs around transit stations. The increase in number and size of new firms translates into greater employment among new entrants near metro stations.

To understand how the increase in and changed composition of firm entry translates into effects on the stock of firms and employment, we turn to our Economic Census data spanning 1990-2013. The entry of larger firms appears to shift job composition toward firms with 47% more employees on average within 1 kilometer of a transit station. On average, there are 177 more employees per 100 residents, suggesting that previously more residential areas are seeing an increase in commercial activity. These employment effects exhibit strong distance gradients, with positive spillovers in neighborhoods within 1-2 kilometers of stations but imprecise and smaller negative effects 2-5 kilometers away, potentially reflecting some competition from newly entering firms. New transit stations don't just have effects on the immediate neighborhoods; given that they are part of a transit network, neighborhoods across the city are likely affected. Thus, we turn to market access based measures (Donaldson and Hornbeck, 2016; Tsivanidis, 2023), and quantify that areas in the peripheries of the city sees a greater increase in their firms' market access to labor, as they benefit disproportionately more from connectivity. Increased market access from the Delhi Metro system is associated with increased employment in firms and larger firm size, specifically in retail and services. This is in line with economic decentralization when transit connects previously isolated peripheral areas (Baum-Snow et al., 2017; Baum-Snow, 2020; Nose and Sawada, 2025), and contrasts with transit studies finding employment centralization (Faber, 2014; Heblich et al., 2020).

The compositional shifts we document—toward larger establishments and consumer-facing services—have important implications for which workers benefit from transit-induced economic growth. Linking back to our motivating fact that female labor force participation increases more near transit stations, we examine whether the new economic activity translates into differential employment effects by gender. There is a doubling of female employment in new firms entering near a transit stations, compared to a 45% increase in male employment. This translates to the stock of employment: of the additional 177 employed per 100 residents, 28 are women. While this might seem like a small portion (17%), the effect size is large compare the to the base of 1 female employee per 100 residents. Moreover, other gendered transit interventions in this context—such as free bus travel for women—have not increased female employment (Chen et al., 2024). Thus, understanding the mechanisms through which Metro Rail access increases female employment is of particular policy interest.

While there are more female-managed firms (Chiplunkar and Goldberg, 2021; Hunt and Moehling, 2024) and firms serving a female clientele (like beauty parlors) entering, female employment is not necessarily siloed to such categories. There is also an increase in the representation of women in a range of firms—larger, male-managed, and selling or providing general products and services. The key factor seems to be the change in size of firms and shift in the composition of industries. Larger firms are ex-ante likely to employ more women (Miller et al., 2022), as they might be more competitive and less discriminatory (Black and Brainerd, 2004; Juhn et al., 2014; Araújo et al., 2024), or because women might prefer to work there due to pay, amenities, prestige, or presence of other women (Kline et al., 2022; Schuh, 2024; Larson-Koester, 2020). Further, the types of firms that are incentivized to locate near transit stations to benefit from footfall also have a larger share of women in their workforce, ex-ante (for example: jewelry stores, medical/diagnostic services, etc.). We show that increased access to female labor doesn't seem to incentivize firm location; female-intensive manufacturing firms (like apparel manufacturing) or B2B service firms (like BPO/call-centers) do not respond to increased Metro Rail access.[3]

To further disentangle whether the differential gender effects arise from improved mobility (women can now reach existing jobs more easily) or from compositional shifts (firms that hire more women locate near stations), we implement counterfactual decompositions. We construct counterfactual female employment in two scenarios: (1) only within firm size-industry change in female employment (i.e., holding baseline firm size-industry composition fixed)—which could be from increased mobility of women, or other hiring changes, and (2) only across firm size-industry changes in female employment (i.e., only letting firm size and industry composition change, but keeping their female-employment shares fixed at the baseline level). The decomposition reveals that firm size and industry composition changes account for the majority of the differential employment effect. This finding underscores that transit infrastructure operates not merely as a commuting technology but reshapes local economic opportunities, with the types of firms attracted to transit access being central to understanding who benefits from infrastructure investment.

[3] there is a suggestive decline in manufacturing firms, possibly due to increased rents along the Metro, as manufacturing needs more land area and prefers to locate in low rent areas.

This paper contributes to three distinct literatures. First, we contribute to research on firm location decisions and hiring patterns by showing how transportation infrastructure reshapes both where firms locate and which workers they employ. Second, we advance the spatial economics literature on transit infrastructure by documenting, to our knowledge, the first empirical evidence that firm heterogeneity and boundaries matter for distributional employment effects of transit. Third, we extend research on gender and commute by providing direct evidence on the labor demand channel, showing that firm responses to transportation infrastructure create new employment opportunities for women beyond traditional mobility effects. A key methodological contribution is the construction and harmonization of multiple administrative datasets at unprecedented spatial granularity for urban India, enabling analysis of firm and employment responses to transportation infrastructure at the neighborhood level.

Firm Location and Workforce Composition: We build on two strands of literature examining firm location and hiring. Rental costs, wages, and agglomeration economies shape firm sorting across space (Lindenlaub et al., 2022). Consumer access represents a particularly important location incentive for retail and service firms (Miyauchi et al., 2021; Bassi et al., 2022; Vitali, 2023; Oh and Seo, 2023). A separate literature documents how firm characteristics predict workforce composition across skill, race, and gender dimensions (Holzer and Ihlanfeldt, 1998; Hjort, 2014; Brinatti and Morales, 2021; Kline et al., 2022; Goraya and Ilango, 2024). Gender patterns are particularly pronounced: women concentrate in larger establishments and female-owned firms (Kline et al., 2022; Schuh, 2024; Chiplunkar and Goldberg, 2021; Hunt and Moehling, 2024; Miller et al., 2022). Competitive pressure reduces discriminatory hiring (Black and Brainerd, 2004; Juhn et al., 2014; Araújo et al., 2024), while women may prefer certain establishments due to wages, amenities, or presence of other female workers (Larson-Koester, 2020; Lordan and Pischke, 2022; Schuh, 2024). We link these strands and contribute to this literature by studying how transit infrastructure changes firm location incentives and resulting employment effects. Consumer-facing establishments (retail and services) respond to transit-induced footfall increases, while business-to-business firms and manufacturers do not. Transit also likely affects sorting through rents and competitive pressures, with larger firms entering near stations. In our context, these compositional shifts toward larger, service-oriented firms drive heterogeneous employment effects across worker groups.

Economic Geography of Transit Infrastructure: A substantial literature examines how transit infrastructure affects spatial economic organization (reviewed in Redding (2025)). Quantitative spatial equilibrium models have been influential in studying welfare effects of public transit infrastructure, accounting for changes in commute costs and residential sorting (Heblich et al., 2020; Tsivanidis, 2023; Zárate, 2022; Severen, 2023; Balboni et al., 2025). Some of these have emphasized distributional employment effects by worker skill levels (Tsivanidis, 2023) and formality (Zárate, 2022). Recent work has looked at new firm entries and increase in local productivity (Busso and Fentanes, 2024). A central modeling assumption in the canonical spatial model is that firms are boundary-less—employment aggregates through constant elasticity of substitution production functions where 100 firms each employing one worker generates identical distributional effects as one firm employing 100 workers. We contribute by empirically documenting how intracity public transit triggers dynamism in number and types of firms, with the resulting changes in firm size and industry composition influencing the distributional effects on employment.

Commute and Gender: Women face higher commute costs than men, with women willing to trade wages for shorter commutes in developed economies (Nafilyan, 2019; Le Barbanchon et al., 2021; Liu and Su, 2024). Safety concerns, social norms, and household responsibilities amplify these constraints in developing contexts (Kondylis et al., 2020; Aguilar et al., 2021; Borker et al., 2021; Jayachandran, 2021). Recent research examines how transportation interventions affect female mobility and employment. Targeted interventions have addresses this by testing a range of interventions from female-only transportation to bringing jobs to women and have recorded increases women's job search and skill acquisition (Cheema et al., 2019; Field and Vyborny, 2022; Ho et al., 2023; Jalota and Ho, 2024; Kapoor and Gade, 2024). Studies of transit infrastructure expansions show mixed employment effects: some find increases in female labor force participation (Martinez et al., 2020; Kwon and Lee, 2024; Seki and Yamada, 2025), while others find limited employment gains from mobility improvements alone (Alam et al., 2021; Chen et al., 2024). Kwon and Lee (2024) provides suggestive evidence that inter-city transit increases demand for female workers in peripheral service sectors.

We extend this literature by providing direct evidence on labor demand constraints. While existing work focuses primarily on supply-side frictions—how transportation enables women to reach existing jobs—we show that structural changes in employment opportunities drive differential gender effects. Transit stations attract larger establishments and consumer-facing businesses that ex-ante employ more women. Using counterfactual decompositions, we quantify that firm compositional changes account for the majority of observed female employment gains, suggesting supply-side transport interventions alone may have limited impact where labor demand remains concentrated in sectors that under-employ women (Klasen and Pieters, 2015).

2 Background

2.1 Delhi: Demographics, Employment, and Firms

Delhi has experienced remarkable population growth, expanding from 3 million residents in 1970 to around 35 million by 2020. This rapid demographic transformation has been accompanied by significant changes in employment patterns and business composition. The majority of Delhi's workforce is concentrated in retail and manufacturing sectors, reflecting the city's role as a major commercial and industrial hub in northern India. Female labor force participation in Delhi, while historically low, has shown gradual improvement over recent decades. Data from 1991, 2001, and 2011 reveals an upward trend in women's workforce participation, though it remains substantially lower than male participation rates—a pattern consistent with broader urban India trends. The city's business landscape is dominated by small-scale enterprises, with the median firm being owner-operated. Between 1990 and 2013, certain industries experienced notable growth, contributing to shifts in the overall firm size distribution and sectoral composition of Delhi's economy.

2.2 Delhi Metro Rail System

Delhi Metro represents a mass transit system with extended planning horizons and implementation idiosyncrasies that provide identification variation for this study.

Congestion and Need for Metro Delhi experienced explosive population growth from

2.6 million in 1961 to 13.7 million by 2001, accompanied by a six-fold increase in motor vehicles, resulting in extreme congestion and air pollution (Siemiatycki, 2006). Rising middle-class wealth and Western cultural influences elevated private vehicles as symbols of status and freedom, driving public transport usage down and creating urgent demand for an alternative mass transit solution (Siemiatycki, 2006).

Planning Origins and Extended Development Timeline: Delhi Metro's development spanned multiple decades, with routing decisions based on historical travel demand projections rather than contemporaneous employment patterns. Transit planning originated with CRRI's comprehensive 1969-70 traffic study, which first recommended mass rapid transit for Delhi. Rail India Technical and Economic Service (RITES) subsequently developed integrated multimodal frameworks in 1989 and 1995 that proposed combined light rail, metro, and BRT systems based on projected travel demand through the 2000s (dmrc, 2010). Despite these early planning efforts, construction only commenced in 1998—nearly thirty years after initial recommendations—due to extended technical studies, political negotiations, and financing arrangements (Siemiatycki, 2006). International funding ultimately provided 64% of project costs through Japan Bank for International Cooperation (Siemiatycki, 2006). This three-decade timeline created temporal disconnects between route decisions and contemporaneous economic activity, with station placements reflecting historical congestion projections rather than current employment patterns and subsequent modifications driven by feasibility constraints rather than firm location considerations.

Plan Modifications and Implementation Idiosyncrasies: Delhi Metro's actual construction exhibited substantial idiosyncrasies in both station placement and opening timing compared to original plans, with modifications driven by feasibility constraints and external factors. Original route approvals differed slightly from final construction, with corridors truncated, extended, rerouted, or pushed to the next phase of construction based on practical constraints[4]. The modifications were done to minimize private land acquisition and disturbance to existing properties, people, and ecology, as well as for integration with the existing

[4]For Phase I, there were supposed to be three main corridors. One of them (Vishwavidyalaya to Central Secretariat) was built as planned, the second (Shahdara to Nangloi) was truncated, with the remaining stops being connected by a different line in the next phase, and the third (Subzi Mandi to Holambi Kalan) was completely eliminated.

metro system, and economic and financial viability (DMRC, 2011). Standalone lines were connected or deleted based on network integration requirements rather than demand projections (DMRC, 2011). Timeline variations included both acceleration for Commonwealth Games 2011 completion (Kayal, 2013) and delays from land acquisition challenges and other logistical factors. These documented modifications created location and temporal variation driven by bureaucratic and engineering constraints rather than endogenous responses to local employment or firm patterns, supporting the identification strategy's assumption of quasi-random metro accessibility changes.

Rollout Timeline and Network Evolution: Delhi Metro's construction proceeded continuously over two decades with major operational expansions occurring in distinct phases, evolving from an initial radial network to include circular connectivity that fundamentally altered the city's transit geography. The Figure 1 shows the evolution of the metro spatially over primarily 3 periods (which we define based on the phase of construction as well as the timeline of the data). The early phase from 2002-2004 connects some of the more central areas of the city, but the majority of the expansion happened in Phase 2 (2005-2011), when the system expanded radially. Phase 3 (2012 onward) added some more radial extensions and circular lines to increase connectivity in peripheries.

3 Data

A key concern with urban, within-city analysis in India is the lack of spatial granularity in the data. To address this, we collate and harmonize multiple sources of administrative data across spatial units and years. Our analysis uses two complementary sources of data on establishments: the first is the Economic Census, which is a stock of formal and informal establishments, and the second is the Registrations of Shops and Establishments, which gives the flow of new establishments from 2011 onward. The Economic Census data are analyzed at the level of a ward, similar to an electoral precinct in the US. The Shops and Establishments Registration data are analyzed at hexagon grid cells of 0.075 km^2.

3.1 Economic Census

For firm-level analysis, we use Economic Census data from 1990, 2005, and 2013, which are repeated cross-sections capturing the universe of non-agricultural establishments (formal and informal) and their employment characteristics. Key variables include number of male and female employees (total and hired), gender of the owner, and industry codes. This enables us to study firm presence, size, industry composition, and gender of employees and owners in response to metro access. While we observe firm-level data, we can only spatially identify the establishment and create a panel at the coarse level of districts, and Delhi only has 8 districts. To get more granularity, we modify and implement the spatial algorithm developed by (Gechter and Tsivanidis, 2023). This enables us to spatially disaggregate Delhi into around 500 urban wards or rural villages.

3.2 Shops and Establishments Registration

To understand how firm location choices respond to the metro, we constructed a novel dataset of commercial establishment registrations in Delhi. These are firms registered under the The Delhi Shops and Establishments Act. This dataset was created through comprehensive web scraping of the Delhi government's official registration portal, yielding over one million registration records for shops and commercial establishments. To our knowledge, this dataset has not been previously utilized in academic research, providing a unique opportunity to examine business formation patterns across Delhi's neighborhoods with information on product/service sold (industry), owner and manager names (enabling gender identification), and number of male and female employees. For the current analysis, we focus on registrations from 2011 onward for firms established less than a year prior to registration.

3.3 Spatial Unit

Our analysis uses two main spatial units: around 500 harmonized 2011 wards and around 1500 hexagon grid cells from the universal H3 index (0.075 km^2). The harmonized 2011 wards were constructed by combining Population Census administrative units with municipal electoral wards for each census year (1991, 2001, 2011), then temporally harmonizing all years to 2011 ward boundaries using area-weighted interpolation to address changing administrative boundaries across census periods. While exact address is available for the Shops and Establishments Registration data, to be able to do analysis across time to study the effect on firms registrations, as well as the account for noise in geolocation, we aggregate firms location to the level of the hexagon.

Given the potentially localized effects of metro access, it was important to get as granular as units as the data would allow. For each census year (1991, 2001, and 2011), we created the most granular spatial units possible by combining data from two complementary sources: Population Census administrative units and municipal electoral wards. This integration was necessary because electoral wards provide greater spatial detail in the urban core of Delhi, while census units offer more granularity at the village and town level in peripheral areas. The combined approach maximizes spatial resolution while maintaining consistent coverage across the state.

To account for changing administrative boundaries between census years, we established the 2011 ward boundaries as the base reference geography. For peripheral areas consisting of villages and census towns, we utilized official census-provided crosswalks. For urban wards where official crosswalks were unavailable, we implemented an area-weighted interpolation approach.

3.4 Other Data

3.4.1 Population Census

For demographic and labor force participation at the residence-level, we use Population Census data from 1991, 2001, and 2011, analyzed at the harmonized 2011 ward level. Key variables include population, number of workers, literacy rates, and scheduled caste/scheduled tribe population, all disaggregated by gender. This enables calculation of employment rates by gender and analysis of neighborhood demographic composition in terms of literacy and socio-economic status.

The population census data are sourced from the Census of India and available in tabular format at year-specific administrative units. For rural areas of the state, these units are villages; for urban areas, these are towns or the Delhi Municipal Corporation along with respective electoral wards (or charges in 1991). These raw data are available from the

Census of India in tabular format.

3.4.2 Metro system

We obtain dates and GIS data for metro stops and lines, including ones that are planned but not yet built, from official Delhi Metro Rail Corporation announcements and mapping sources. Metro exposure, our key treatment variable, is measured at the spatial unit level based on presence of metro stops within ward boundaries or within specified distances (1km, 2km, etc.) from the centroid of the spatial unit (ward or hexagon). This enables analysis of metro accessibility changes over time across different spatial scales.

3.4.3 Commuting

The three key datasets on commuting are: (1) Population Census 2011 transportation: from which we get mode and distance to work at district-gender level, (2) OLA Mobility Survey 2022: individual level dataset with origin and destination neighborhood for commutes, and (3) mobile phone location data for 2019, with density and flows aggregated at the geohash 5 level (4.88km×4.88km), provided by Cuebiq.

4 Motivating Facts

4.1 Increase in Labor Force Participation near Metro Stations

We study the effect of metro exposure on the employment rates of residents in a given ward, utilizing Population Census data from 1991, 2001, and 2011 at the 2011 harmonized ward level. We estimate the following specification:

$$Y_{pt} = \beta_1 \text{Treated}_p \times \text{Year2011}_t + \beta_2 \text{Treated}_p \times \text{Year2001}_t + \delta_t + \gamma_p + \epsilon_{pt} \tag{1}$$

where Y_{pt} is the employment outcome (proportion of population employed) in ward p at time t, Treated_p is an indicator equal to 1 if ward p has a metro stop by 2011 and 0 otherwise, Year2011_t and Year2001_t are year indicators, δ_t are year fixed effects, and γ_p are ward fixed effects. We weight the regressions by total population at the ward level, as the data are only available at ward-level aggregates and the outcome variables are proportions. The key coefficient of interest is β_1, which captures the effect of metro access on employment outcomes by 2011, noting that metro roll out started in 2002. Similar to the analysis with the Census of Firms, we restrict our analysis to ward that eventually received metro stations by 2023 and test for parallel trends. We account for spatial autocorrelation using Conley standard errors with a 5km bandwidth, recognizing that employment outcomes in neighboring wards may be correlated due to spillover effects or common unobserved shocks.

Figure 2 presents the estimated treatment effects of metro access on labor force participation at varying distances from transit stations. Panel A shows that overall labor force participation increases in wards closer to metro stations, with the effect declining monotonically with distance. The increase is 5.3 percentage points for wards within 1 kilometer of a station, falling to (an insignificant) 1.3 percentage points for wards 5-10 kilometers away.

This aggregate pattern masks heterogeneity by gender and location. Panel B reveals that the increase in labor force participation is driven primarily by women, with female labor force participation rising by 7.5 percentage points in wards within 1 kilometer of a station. The female employment effect also exhibits a distance gradient, declining at distances beyond 2 kilometers from stations. Panel C demonstrates that these effects are concentrated in peripheral areas: when restricting the sample to wards within 5 kilometers of the central business district, the overall labor force participation effects are larger and more precisely estimated in areas closer to transit stations, consistent with peripheral residents facing higher commute costs that transit access alleviates.

4.2 Increase in Firm Entry near Metro Stations

The increase in labor force participation documented in Section 4.1—particularly pronounced in peripheral areas—could reflect improved commuting access enabling residents to reach employment opportunities in the city center. However, we observe a second spatial pattern that suggests transit infrastructure also reshapes the local economic landscape: firm entry concentrates systematically near metro stations, especially in peripheral neighborhoods.

Figure 3 presents mean changes in firm entry by distance from the central business district and proximity to metro stations. Among neighborhoods without nearby transit access (blue triangles), firm entry follows an inverted U-shaped pattern: entry rates increase from the city center, peak at approximately 10 kilometers, then decline steadily in more peripheral locations. Beyond 15 kilometers from the CBD, neighborhoods without transit stations experience minimal firm entry, consistent with declining accessibility in areas distant from the urban core.

Transit proximity fundamentally alters this spatial pattern. Neighborhoods within 1 kilometer of a metro station (red circles) exhibit systematically higher firm entry rates at all distances from the CBD. Critically, the transit effect intensifies with distance from the center: while station proximity yields modest advantages in core areas (0-5 kilometers), the gap widens considerably in peripheral locations. Beyond 10 kilometers from the CBD—where non-connected neighborhoods experience declining firm entry—transit-adjacent neighborhoods maintain higher entry rates, comparable to levels observed much closer to the city center.

Thus, while employment increases near metro stations in Section 4.1 could be from increased commuting ability of workers, Figure 3 could also suggest that there could be some increase in local employment as well.[5] While the increase in firm entry near transit stations could be from endogenous neighborhood characteristics (which is what we will address through our empirical strategies), this pattern motivates us to study the effect of transit access on firm entry, change in firm and industry composition, and employment.

5 Transit Infrastructure Effects on Firm Entry

5.1 Empirical Strategy

For the firm entry analysis, we leverage the Phase 3 metro expansion (2011-2024) and implement a staggered difference-in-differences design following Callaway and Sant'Anna (2021). Our approach addresses the challenge that metro stations opened at different times across Delhi, requiring methods robust to heterogeneous treatment timing.

Our baseline specification estimates dynamic treatment effects using the following event study framework:

$$Y_{pt} = \alpha + \sum_{k \neq -5} \beta_k \cdot \mathbb{1}[\text{RelTime}_{pt} = k] + \gamma_p + \delta_t + \epsilon_{pt} \tag{2}$$

[5] we see suggestive evidence of increased correlation in residence employment and workplace employment in peripheries.

where Y_{pt} represents firm entry outcomes (number of new firms, employment, or firm characteristics) in neighborhood p during 6-month period t. We define neighborhoods using H3 hexagonal spatial indexes at resolution 8, which partition Delhi into approximately 500-meter radius hexagons. This granular geographic unit allows us to precisely measure proximity to metro stations while maintaining computational tractability.

The variable RelTime_{pt} denotes event time relative to metro station opening in neighborhood p, measured in 6-month periods. We bin event time to reduce noise while preserving dynamic patterns. The coefficients $\{\beta_k\}$ trace out the treatment effect trajectory before and after metro opening. We normalize β_{-5} to zero, making period $k = -5$ (2.5 years before opening) the reference period. Treatment begins not at the operational opening date but two years prior, corresponding to the period between the start of testing and when the transit station becomes operational. The end of construction and beginning of testing may generate anticipatory registrations and entries from businesses, as the station's imminent operation becomes apparent. We include neighborhood fixed effects (γ_p) and 6-month period fixed effects (δ_t), and cluster standard errors at the neighborhood level.

In our base specification, we use information from planning documents that detail Phase 3 construction plans and deviations. In many cases, plans were designed to construct lines along major roads to reduce costs and minimize land acquisition and disturbance to residents and businesses. We restrict the sample to neighborhoods within 1 kilometer of major roads (defined as motorways, trunk roads, or primary roads from OpenStreetMap). Within this sample, we compare neighborhoods within 1km of Phase 3 stations (treated) to those beyond 1km of any station but still near major roads (control).

We also use an alternate specification using stations from Delhi's 2002 master plan that were planned but never constructed, as well as Phase 4 stations not yet built by 2024. This addresses concerns that station placement reflects omitted neighborhood characteristics. If our effects persist when comparing to planned-but-not-built locations, it suggests metro impacts operate through actual connectivity rather than unobserved place-based factors.

Our identification strategy relies on two key assumptions:

- Parallel Trends; n the absence of metro station openings, neighborhoods that eventually receive stations would have followed similar trends in firm entry as comparison neighborhoods. We provide evidence for this assumption by: (1) showing insignificant pre-treatment coefficients in our event studies, (2) formally testing joint nullity of pre-treatment effects, and (3) using reasonable comparisons, such as roadways and planned but not built stations.

- No anticipation before testing: We account for potential anticipation once testing begins, but assume that before testing, firms do not enter as construction and delays can hurt business.

5.2 Results

We begin by examining the dynamic response of firm entry to metro station openings. Figure 4a presents event study estimates of treatment effects on the number of new firm registrations in treated neighborhoods relative to comparison neighborhoods in a 6-month period. The average treatment effect on the treated (ATT) is 8.91 additional firms per neighborhood per 6-month period relative to a baseline mean of 6.2 firms in control neighborhoods, representing a 144% increase in the flow of new establishments. We do not observe significant pre-trends. The effect remains elevated and statistically significant at conventional levels throughout the post-treatment period. While the magnitude declines slightly over time, coefficients remain significantly above zero, indicating that metro access generates persistent changes in firm location decisions rather than temporary responses to station openings.

Figure 4b shows that this increase in firm entry is driven almost entirely by establishments serving end consumers (business-to-consumer firms or B2C firms). B2C firms increase by 280.55% (SE: 69.53) relative to a baseline mean of 2.4 firms, while B2B firms show no differential response to transit infrastructure. This pattern is noteworthy given that transit access is typically viewed as a mechanism for firms to access labor pools. Table 1 (Panel A, Col 5) confirms that firms relying on high-skill workers are not more likely to enter near transit stations. These findings link back to the motivating observation that increased customer foot traffic near metro stations provides location advantages for consumer-facing establishments, suggesting that demand-side effects dominate labor access considerations in firm sorting around transit infrastructure.

In addition to entry of more firms, the firms entering near a transit station are 19% larger (more employees) and 94% more likely to be specialized, i.e., the manager being separate from the owner (Table 1, Panel A, Cols 2-3). The results on more firm entries, driven by B2C firms, and more specialized firms also hold with an alternate specification (Table 1, Panel B), using a 2002 map of the planned Delhi metro network (which mapped out the plan for line construction up to 2021).Using planned but not built lines as comparison, there is a 67% increase in the number of new firm registrations within 1km of a transit stations (Table 1, Panel B, Col 1).

The increase in firm entry as well as increased size of firms entering contributes to an increase of 56% in the number employed in new firms, relative to the base in the comparison group (Table 1, Panel A, Col 5). While employment in new firms itself is not directly indicative of increase in employment in general, but the key thing to note here is the composition of industries that employment seems to be absorbed by—larger, more specialized, and likely more productive with higher pay and amenities. In the next section, we look at how these new firm entry results translate to the stock of firms and employment.

6 Transit Infrastructure on Firm Composition and Employment

The sustained entry of new, larger, and more specialized firms near transit stations raises the question of whether these patterns translate into changes in the overall stock of firms and employment. While the firm registration data capture new entrants, they do not reveal net effects on employment once accounting for potential firm exits, relocations, or changes in incumbent firm size. To examine these broader impacts on local economic activity, we turn to establishment-level census data that provide comprehensive snapshots of all firms operating in Delhi at three points in time. We first investigate how metro proximity affects the stock of employment and firms, exploiting the Phase 2 expansion (2005-2013). We then examine whether transit-induced improvements in firm commuter market access—capturing firms' ability to draw workers from across the expanded transit network—generate additional employment effects beyond localized station proximity.

6.1 Metro Proximity and Stock of Employment and Firms

Table 2 presents our main results on how metro station proximity affects employment in firms, average firm size, and firm size distribution. Below, we introduce the main empirical strategy, alternate specifications for robustness, and talk through the key results. Across specifications, we find statistically and economically significant increases in employment and shifts toward larger establishments in wards close to metro stations, with no evidence of differential pre-trends.

6.1.1 Empirical Strategy

Our baseline specification exploits the rollout of Phase 2 metro stations, estimating:

$$Y_{pt} = \beta_1(\text{Phase } 2_p \times \text{Year2013}_t) + \beta_2(\text{Phase } 2_p \times \text{Year2005}_t) + \delta_p + \sum_t \gamma_t' \mathbf{X}_p + \epsilon_{pt} \quad (3)$$

where Y_{pt} represents employment or firm outcomes in ward p at time $t \in \{1990, 2005, 2013\}$. The variable Phase 2_p is an indicator equal to one if ward p's centroid is within a specified distance of a Phase 2 metro station (opened between 2005-2013) and zero otherwise. We exclude wards within 1 kilometer of Phase 1 stations to focus cleanly on Phase 2 expansions. The coefficient β_1 captures the treatment effect of metro access by 2013, while β_2 tests for differential pre-trends between 1990 and 2005.

We include ward fixed effects (δ_p) to control for time-invariant ward characteristics. The vector $\mathbf{X}_p$ contains flexible year fixed effects: log distance to the city center and log distance to the nearest Phase 1 metro station, each interacted with year indicators ($\sum_t \gamma_t' \mathbf{X}_p$). As the Phase 2 expansion is radial in nature, expanding from the city city center to the peripheries and, by the nature of the metro network, the phase 2 lines expand out of the phase 1 lines, we account for differential time trends in wards by distance to the central business district and already existing metro lines. These controls account for differential trends by distance to the city center and exposure to earlier metro infrastructure. All regressions are weighted by ward area. Standard errors are adjusted for spatial correlation using Conley standard errors with a 5-kilometer cutoff.

Table 2 presents estimates across five specifications that vary the treatment definition and comparison group. In Column 1, we define treatment as proximity within 1 kilometer of a Phase 2 station and compare to all areas beyond 2 kilometers from any Phase 2 station. To account for potential spillover effects that could attenuate our estimates, we exclude wards located 1-2 kilometers from metro stations. This specification provides a cleaner comparison between directly treated areas and those sufficiently distant to be unaffected by proximity benefits.

Column 2 narrows the comparison group to only wards within 1 kilometer of not-yet-built stations (while maintaining the 1km treatment definition and 1-2km spillover exclusion). This approach leverages idiosyncratic variation in construction timing among planned stations while ensuring treated and comparison wards share similar observable characteristics related to metro placement decisions. Column 3 expands the treatment definition to wards within 2 kilometers of a Phase 2 station, with the comparison group being wards within 2 kilometers of not-yet-built stations. Column 4 examines whether areas 2-5 kilometers from stations experience effects, using areas beyond 5 kilometers as the comparison group. Finally, Column 5 uses a continuous specification, replacing the binary treatment indicator with log distance to the nearest Phase 2 station, allowing us to estimate the distance gradient of metro effects. The last three specifications help establish the spatial extent of metro impacts.

Across all three outcome panels—employment per capita (Panel A), log average firm size (Panel B), and share of large firms (Panel C)—we apply these five specifications to assess the robustness of our findings.

6.1.2 Findings

Metro station proximity generates substantial increases in employment density and shifts toward larger establishments. In wards within 1km of a Phase 2 station, employment per capita increases by 0.88 workers per person, which is a ten-fold increase over the mean in the comparison group of 8.3 workers per 100 residents in a ward (Table 2, Panel A, Column 1). Narrowing down to only comparing against not-yet-treated wards, there is a similar but imprecise effect size increase given the smaller sample (Table 2, Panel A, Column 2). When we expand the treatment radius to 2 kilometers (Column 3), the effect size is smaller, the effect size is smaller, with a 3.5 times increase in employment per capita, over the base of 18 workers per 100 residents, suggestive of a decay in the employment effects with distance from the metro station. If positive effects near the metro station are primarily coming from relocation or closing of nearby firms in favor of firms closer to the metro station, we would expect negative employment effects in areas further out from the metro station, but still close enough to have such spillovers. We look at wards within 2-5 kilometers from a metro station to test for this; there is a small negative but statistically insignificant decrease of 0.37 workers per capita in these areas, which could be suggestive of some negative spillovers, but with large standard errors (Table 2, Panel A, Column 4). Column 5 further shows that the employment effects of the metro station decay with distance from the station. The employment effects near stations could point to increase in the number of firms and/or increase in the size of firms, which is what we look at next.

Metro access also induces compositional shifts toward larger establishments. Average firm size increases by 42-47% in wards with metro exposure within 1km, over the base of 2.7-3.8 workers per firm (Table 2, Panel B, Columns 1 and 2). The effects are again smaller accounting for a larger area around the metro station, at 33% increase in firm size within a 2km radius, and still positive but insignificant increase of 13.6% in the 2-5km range (Table 2, Panel B, Columns 3 and 4). In Panel C of Table, we specifically look at the share of firms with 10 or more workers, since this is the employment threshold at which more labor regulations start to apply and thus such firms are more likely to be formal as well as relatively more productive (Hasan and Jandoc, 2013; Amirapu and Gechter, 2020; Rajagopalan and Shah, 2024). Within 1km of metro stations, there is a 5-7 percentage point increase in the share of 10+ worker firms, which is a doubling relative the the baseline share (Table 2, Panel C, Columns 1 and 2). This effect again decays with distance 3.5pp-1.3pp increase on expanding to 2 to 5 kilometers away from the metro station (Table 2, Panel C, Columns 3 and 4).

The decay with distance suggests that metro access affects employment through spatial spillovers extending beyond individual stations. Further, the metro is a transit network, not all areas benefit similarly from changes to the metro system. To account for these, we turn the commuter market access based measure in the next section.

6.2 Commuter Market Access and Firms

6.2.1 Empirical Strategy

To assess how metro expansion shapes employment and firms by changing labor market accessibility, we construct commuter market access (CMA) measures which capture how transit infrastructure affects firms' access to workers and residents' access to jobs through the commuting network (Donaldson and Hornbeck, 2016; Tsivanidis, 2023).

CMA Construction

We calculate Firm Commuter Market Access (FCMA) and Resident Commuter Market Access (RCMA) as sufficient statistics of network connectivity, following the method put forth in Tsivanidis (2023). FCMA (Ω_j^F) reflects firms' access to residential labor supply, while RCMA (Ω_i^R) captures residents' access to employment opportunities. These measures satisfy the following system:

$$\Omega_i^R = \sum_{j \neq i} d_{ij}^{-\theta} \frac{L_j^F}{\Omega_j^F}, \quad \Omega_j^F = \sum_{i \neq j} d_{ij}^{-\theta} \frac{L_i^R}{\Omega_i^R} \tag{4}$$

where d_{ij} represents commute costs between locations i and j, L_j^F is employment at location j, L_i^R is residential population at location i, and θ is the commute elasticity. We solve this system iteratively, holding population and employment fixed at baseline (1990) levels to isolate the effect of changing transit infrastructure.

We construct commute costs as $d_{ij} = \exp(\kappa \cdot t_{ij})$, where t_{ij} is travel time in minutes from ward i to ward j using public transport and walking and κ maps commute time to commute cost (we assume $\kappa = 0.01$, based on Ahlfeldt et al. (2015). Travel times are computed using the Fast Marching Method on speed rasters that incorporate metro lines, bus routes, and walking speeds; thus the changing metro network changes travel times between i and j. We assume the commute elasticity to be $\theta = 3.4$, based on Tsivanidis (2023), but also representative of commute elasticities between 2-4 estimated in an Indian urban city (Mumbai) (Gechter and Tsivanidis, 2023). With the two equations and two unknowns (Ω_i^R and Ω_j^F), we retrieve the measure for Firm's Commuter Market Access which we will use to measure the effects on firms and employment in this section.

Regression Specification

Our baseline specification examines whether changes in ln(FCMA) predict employment and firm composition:

$$Y_{pt} = \beta_1(\Delta \ln(\text{FCMA})_p \times \text{Year2013}_t) + \beta_2(\Delta \ln(\text{FCMA})_{\text{Future},p} \times \text{Year2013}_t) + \delta_p + \gamma_t + \epsilon_{pt} \quad (5)$$

where Y_{pt} represents employment or firm outcomes in ward p at time $t \in \{1990, 2005, 2013\}$. The variable $\Delta \ln(\text{FCMA})_p$ measures the log change in firm commuter market access from 2005 to 2013 due to metro expansion. The coefficient β_1 captures the causal effect of improved access of firms to labor. We include $\Delta \ln(\text{FCMA})_{\text{Future},p}$—the anticipated change in FCMA from 2013-2022 based on planned metro extensions—as a falsification test, with β_2 testing whether future accessibility improvements spuriously predict current outcomes. The regressions include ward (δ_p) and year (γ_t) fixed effects. Standard errors are adjusted for spatial correlation using Conley standard errors with a 5-kilometer cutoff.

Table 3 presents results across five outcomes: total employment in a ward(Column 1), average firm size (Column 2), and the share of firms with 10+ workers in manufacturing (Column 3), high-skill professional services (Column 4), and business-to-consumer industries (Column 5). Panel A estimates the baseline specification. Panel B examines whether employment effects vary in high vs. low rent areas (rents are assessed pre-metro expansion by the city municipal government); for this we interact $\Delta \ln(\text{FCMA})$ with an indicator for ward having above-median rent. Panel C interacts $\Delta \ln(\text{FCMA})$ with an indicator for ward being within 1 kilometer of a metro station, assessing whether proximity to station, beyond the metro network's effect on access, has an additional impact on employment.

6.2.2 Findings

In general, increase in firm commuter market access leads to increase in total employment and a shift toward larger firms, especially those require high-skill labor and/or are consumer-facing. However, there is heterogeneity in the types of firms that respond change in FCMA given underlying land rents and proximity to metro station, with larger business-to-consumer firms more likely to locate in higher rent areas an closer to metro stations.

In Panel A of Table 3, we look at the effects of increase in FCMA and to make the estimates more interpretable, the square brackets report the effect size when FCMA increases from the 25th to 75th percentile (which is a 0.123 log point increase). The total employment in a ward goes up by 16.7% (Panel A, Column 1), with the firm-level data showing that average firm size increases by 6.6% (Panel A, Column 2). Interestingly, manufacturing firms do not respond to increase in FCMA from increasing metro access, even though they labor-intensive (Panel A, Column 3). Instead, it is firms that rely on high-skill workers (such as finance, IT, etc.) and direct consumer interactions (such as retail, personal services) that are more likely to locate in areas with increasing FCMA; a move from 25th to 75th percentile in FCMA is associated with a 0.09 percentage point increase in high-skill firms (over a base of 0.6% of the firms being high skill firms with 10+ workers, this is a 15-fold increase) and with a 0.14 percentage point increase in business-to-consumer (B2C) firms (also a 15-fold increase over the base on 0.9% firms). The falsification test using anticipated future accessibility gains (2013-2022) shows no significant relationship with current outcomes, providing confidence that our estimates capture the causal effect of realized infrastructure improvements rather than confounding trends in areas selected for metro expansion.

In Panel B of Table 3, we look at heterogenous effects of change in FCMA by assessed rents per square foot of wards. The rationale here is that we could explain the increase in firm entry we see along metro stations by the ability for firms to now be able to locate in lower rent areas which experience an increase in market access due to metro connectivity. In this case, we would expect that ward with below-median rent should see greater increases in employment with the same increase in FCMA. However, it is very possible that rents themselves increase due proximity to metro (Suri and Cropper, 2024); this is just a suggestive exercise to explore one potential mechanism through which firms might be more likely to enter in peripheral areas with expansion of metro, to take advantage of places with lower rents and building density. Another potential channel could be that these assessed rents are indicative of the socio-economic status of the residents living in the wards, so that could also influence firm composition.

Higher rent is in general associated with lower employment; an increase in FCMA from 25th to 75th percentile in a below-median ward is associated with a 13.8% increase in employment, thus suggesting that there might be more firms or larger firms taking advantage of (initially) cheaper areas which benefit from metro accessibility (Panel B, Column 1). Change in FCMA in above-median rent areas is not significantly different that that in low-rent areas (if anything, the increase in FCMA just seems to counteract the low employment in high-rent areas). Panel B, Column 2 shows that there are no statistically significant differences in how firm size responds to FCMA changes in high vs. low rent areas; this could be indicative of there being heterogeneity by industry. Manufacturing again does not significantly respond to change in FCMA (Panel B, Column 3). In low-rent areas, the 25th-to-75th percentile FCMA improvement generates a 0.03pp increase in likelihood of a large, high-skilled firm (Panel B, Column 4). Further, the interaction terms reveal that high-rent areas experience additional gains concentrated in skilled service firms: the share of high-skill professional firms increases by an additional 0.23 percentage points (a 58% increase over the baseline of 0.4%), while B2C firms increase by an additional 0.18 percentage points (a 26% increase). This heterogeneity suggests that neighborhoods with higher initial land values (which could be proxies for SES of residents) attract more skilled, service-oriented establishments when labor becomes more accessible, potentially reflecting complementarities between skilled workers, valuable locations, and service sector activity.

Proximity to metro stations amplifies the market access effects for especially consumer-facing firms (Panel C, Column 5). The baseline effect of station proximity itself shows a 0.5 percentage point increase in B2C firms, suggesting stations attract customer-facing establishments through foot traffic or amenity effects beyond pure labor accessibility. A 25th-to-75th percentile FCMA improvement in ward that is further within 1km of a metro stations generates an additional 0.23 percentage point increase in the likelihood of a large, B2C firm, a 25-fold increase over the baseline. Thus, beyond the increased labor accessibility that the metro system provides, B2C firms particularly might benefit more from particularly being closer to a metro station.

These results demonstrate that transit infrastructure affects employment not only through direct station proximity but also through broader improvements in firms' access to labor across the entire commuting network. By the nature of the design of the metro systems, the larger increases in firm market access are in the peripheral areas of the city, rather than the already high-market-access core, thus, the effects point to increasing employment, especially from larger firms in peripheral areas. High-skill industries in particular seem to be very responsive to increased market access to labor. Moreover, there are certain firms that have additional gains from being in the vicinity of a metro station. This could be because metro stations also provide other amenities to surrounding areas such as increase in footfall or customer visibility, which retail firms highly value.

Taken together with the locally concentrated effects of metro stations on increased employment in Section 6.1, the changing firm size and industry composition can have implications for *who* benefits in terms of employment, as firms and industries differ in their workforce composition. This is what we will explore in the next section (Section 7).

7 Transit Infrastructure and Heterogenous Employment Effects

The compositional shifts we document—toward larger establishments and consumer-facing services—raise a critical question: which workers benefit from this transit-induced employment growth? This question is particularly salient in the context of Delhi, where female labor force participation rates remain extremely low at 11% (Section 2). While our motivating fact in Section 4.1 shows that FLFP increases more than male participation near metro stations, it remains unclear whether this reflects improved mobility to existing jobs or changes in job opportunities for women. Understanding this distinction has important policy implications: many interventions focused solely on reducing women's commuting costs—including making bus travel free for women—have not led to increased female employment (Chen et al., 2024). We therefore examine heterogeneous employment effects by gender, with particular attention to the role of firm composition.

Figure 5 provides suggestive evidence that the types of firms locating near metro stations differ systematically in their propensity to hire women. The figure plots business types by their average distance to the nearest metro station and the proportion of female workers they employ. Firms that locate closer to metro stations—including beauty parlors, retail stores, banks, and medical services—tend to employ substantially higher shares of women (above the median of 10.6%), while firms locating farther from stations—such as logistics, manufacturing, and construction—employ predominantly male workforces. This pattern suggests that metro-induced compositional shifts may generate differential employment effects not only through improved commuting access but also by attracting firm types that are ex-ante more likely to hire women.

We test this hypothesis by examining employment effects by gender in newly entering firms near metro stations, followed by counterfactual decompositions to quantify how much of the gender gap reflects compositional shifts versus mobility improvements.

7.1 Female Employment in New Firms

Empirical Approach

Our analysis leverages the Phase 3 metro expansion (2011-2024) using a staggered difference-in-differences design following Callaway and Sant'Anna (2021). We partition Delhi into approximately 500-meter radius neighborhoods using H3 hexagonal spatial indexes and aggregate outcomes to 6-month periods. We compare neighborhoods within 1km of Phase 3 stations (treated) to those beyond 1km of any station but within 1km of major roads (comparison), restricting to road-adjacent neighborhoods since metro construction often followed existing road networks. Treatment begins two years before operational opening to capture anticipatory firm entry during the testing phase. We estimate dynamic treatment effects in event time, normalizing the period 2.5 years before opening to zero, and include neighborhood and time fixed effects with standard errors clustered at the neighborhood level (see Section 5.1 for full specification details).

Findings

Figure 6 presents results on heterogenous employment in new firms due to transit infrastructure access: female employment in newly registered firms increases more than male employment following transit station openings. The event study shows that female employment increases by 98% relative to a baseline mean of 3 workers per neighborhood in a 6-month period, compared to a 45% increase for male employment over a baseline of 18 workers. The gender gap in employment in new firms reduces from 1:6 to 1:4 in favor of women with proximity to transit infrastructure.

These gendered employment gains in new firms mask important heterogeneity in which types of firms are hiring women and whether female employment increases are concentrated in traditionally "female-friendly" establishments or extend more broadly. Building on the patterns shown in Figure 5, we now examine which newly entering firms are contributing to female employment growth. Panel A of Table 4 characterizes the types of firms entering near metro stations, while Panel B compares female versus male employment growth across different firm characteristics.

Metro stations attract industries that historically employ more women. Firms in high metro-propensity industries—those that were closer to Phase 1-2 metro stations during the baseline period and tend to be more consumer-facing and skill-intensive—increase by 48.8% relative to a baseline mean of 10.4 firms per neighborhood (Table 4, Panel A, Column 1). In contrast, firms in low metro-propensity industries show a smaller and statistically insignificant 35.3% increase (Table 4, Panel A, Column 2). These patterns indicate that metro stations disproportionately attract the types of industries that have ex-ante employed more women.

Beyond industry composition, metro access induces marked shifts in firm ownership and management toward greater female representation. Female-managed firms increase by 180% over a baseline mean of only 2.6 such firms per neighborhood (Table 4, Panel A, Column 3). This represents a larger percentage increase than the 46.8% growth in male-managed firms over their baseline of 17.4 firms (Table 4, Panel A, Column 4). We also observe an 86.3% increase in firms with at least one female employee, over a baseline of 11.4 firms (Table 4, Panel A, Column 5), while there is no significant change in firms with no female employees (Table 4, Panel A, Column 6). Female-majority firms—where women comprise more than half the workforce—increase by 184.1%, compared to only a 40.9% increase in male-majority firms (Table 4, Panel A, Columns 7-8). Together, these results indicate that metro stations attract not only consumer-facing industries that value female workers, but also catalyze entry of firms with greater female ownership and representation.

However, female employment gains extend well beyond these "female-friendly" firm types. Panel B of Table 4 compares female versus male employment growth across different firm characteristics, revealing that women's employment increases broadly—including in male-managed, larger, and more productive establishments. Female employment in general industries (not specifically targeting female clientele) increases by 95.8% over a baseline mean of

2.6 female workers per neighborhood (Table 4, Panel B, Column 1). While female employment in female-oriented industries also increases by 93.0%, this effect is imprecise due to the small baseline of 0.2 workers (Table 4, Panel B, Column 2).

Female employment increases even in male-managed firms, where female workers grow by 92.8% over a baseline of 2.1 workers, compared to only a 35.7% (statistically insignificant) increase for male workers in the same firms (Table 4, Panel B, Columns 3-4). This suggests that male-managed firms near metro stations are actively hiring more women, rather than female employment gains being driven solely by female-managed establishments.

Metro access also enables women to access employment in larger, more formal establishments. In firms with 10 or more workers—establishments that are more likely to be formal and productive given India's employment-based regulatory thresholds—female employment increases by 114.6%, translating to 1.6 additional female workers per neighborhood over a baseline mean of 1.4 workers (Table 4, Panel B, Column 5). In contrast, male employment in such firms increases by only 44.4% (statistically insignificant) over a much larger baseline of 7.2 workers (Table 4, Panel B, Column 6). Given that male employment in 10+ worker firms was five times higher than female employment at baseline, these differential growth rates narrow the gender gap to approximately 2-3:1.

Finally, women also gain access to more differentiated and potentially productive firms. In establishments where the owner and manager are different individuals—a marker of organizational complexity and scale—female employment increases by 82.0%, compared to a 54.2% increase for male employment (Table 4, Panel B, Columns 7-8). This difference is notable given that both coefficients are statistically significant, suggesting that metro access enables women to access not just more jobs, but higher-quality jobs in more sophisticated firms.

Taken together, these results demonstrate broad-based female employment gains. Metro stations attract consumer-facing industries and female-managed firms that disproportionately employ women, but female employment increases extend far beyond these firm types. Women gain employment in male-managed firms, large formal establishments, and productive differentiated firms—precisely the types of jobs that offer better pay, stability, and career prospects. The next section explores how this entry of firms translates in the heterogenous employment effects in the stock, as well as how much of the effects on women are driven by the change in firm composition.

7.2 Decomposing Employment: Within vs. Across Firm Composition

Having established that metro proximity generates increases in female employment alongside compositional shifts toward larger establishments and female-intensive industries, we now investigate the mechanisms underlying these employment gains. Specifically, we decompose the increase in female employment into two channels: changes in firm composition (metro stations attracting firm types that hire more women) versus changes in hiring behavior within existing firm types (firms near metro stations employing more women conditional on firm characteristics).

Table 5 presents the gender-disaggregated employment effects alongside a counterfactual decomposition of female employment changes. Male employment per capita increases by 149 workers per 100 residents in treated wards, representing a ten-fold increase relative to the baseline mean of 14.4 workers, though this effect is imprecise (Column 1). Female employment per capita increases by 29 workers per 100 residents ($p < 0.1$), more than a 20-fold increase over the low baseline mean of just 1.36 female workers per 100 in the population (Column 2)

To understand whether these employment gains reflect changes in which types of firms locate near metro stations versus changes in hiring practices within firm types, we conduct a decomposition. We express female employment in ward p at time t as:

$$\text{FemEmp}_{p,t} = \sum_{s} \text{Emp}_{s,p,t} \times \text{FemShare}_{s,p,t} \tag{6}$$

where s indexes firm type, defined as the interaction of industry (approximately 80 classifications) and firm size bin. Female employment in a ward equals the sum across all firm types of total employment in each firm type multiplied by the female share of the workforce in that firm type. This decomposition allows us to separate compositional effects (changes in $\text{Emp}_{s,p,t}$ across firm types) from within-type effects (changes in $\text{FemShare}_{s,p,t}$).

We construct two counterfactuals. First, we fix the distribution of employment across firm types at baseline (1990) proportions while allowing total employment and female shares within firm types to change: $\text{Emp}_{s,p,t} = \frac{\text{Emp}_{s,p,1990}}{\text{Emp}_{p,1990}} \times \text{Emp}_{p,t}$. This isolates within-firm-type changes in female employment, such as firms near metro stations hiring more women conditional on industry and size. Second, we fix the female share within each firm type at its baseline level: $\text{FemShare}_{s,p,t} = \text{FemShare}_{s,1990}$. This isolates the contribution of compositional change—if metro access shifts employment toward firm types that historically employed more women, female employment would increase even absent any change in hiring behavior within firm types.

(Table 5, Column 3) presents results when we hold the firm type distribution constant at 1990 levels, allowing only within-firm-type changes in female shares. The estimated treatment effect is 6.9 workers per 100 residents, but this is statistically insignificant. (Table 5, Column 4) presents results when we hold female shares within firm types constant at 1990 levels, allowing only compositional change. The estimated treatment effect is 10.4 workers per 100 residents ($p < 0.1$), which is closer but yet smaller than the true effect in Column 2.

These results indicate that compositional change is a larger driver of female employment gains near metro stations, though neither channel alone fully accounts for the observed effect, suggesting that the two mechanisms interact to amplify female employment gains.

8 Conclusion

Understanding how firms respond to transportation infrastructure is critical for predicting the full employment effects of transit investments. While conventional analysis focuses on how infrastructure improves workers' access to existing opportunities, our findings demonstrate that transit also fundamentally reshapes the local economic landscape through firm location decisions. Using the phased rollout of Delhi Metro as a natural experiment, we document that public transit operates through two distinct channels: reducing commuting costs for workers and inducing compositional shifts in local firm structure.

Metro access generates 2.5 times more firm entries relative to baseline, with these new establishments being systematically larger and more specialized than incumbents. Employment per capita increases ten-fold in neighborhoods within one kilometer of stations, driven by shifts toward larger establishments and consumer-facing businesses. Average firm size increases 42–47% over baseline, while the share of firms with ten or more workers—the threshold at which formal labor regulations typically apply—doubles from baseline levels. These compositional changes reflect firms' responses to metro-induced increases in foot traffic and consumer access rather than simply relocating existing economic activity.

The firm composition changes generate heterogeneous employment effects across worker types. Employment increases differ by worker characteristics that correlate with propensity to work in different firm types and sensitivity to commuting costs. Our counterfactual decompositions reveal that compositional shifts—the changing mix of firm types locating near metro stations—account for the majority of differential employment effects across worker groups. When we hold the distribution of firm types constant at pre-metro levels, differential employment effects decline by approximately two-thirds, indicating that the types of firms attracted to transit access determine which workers benefit most from infrastructure investment.

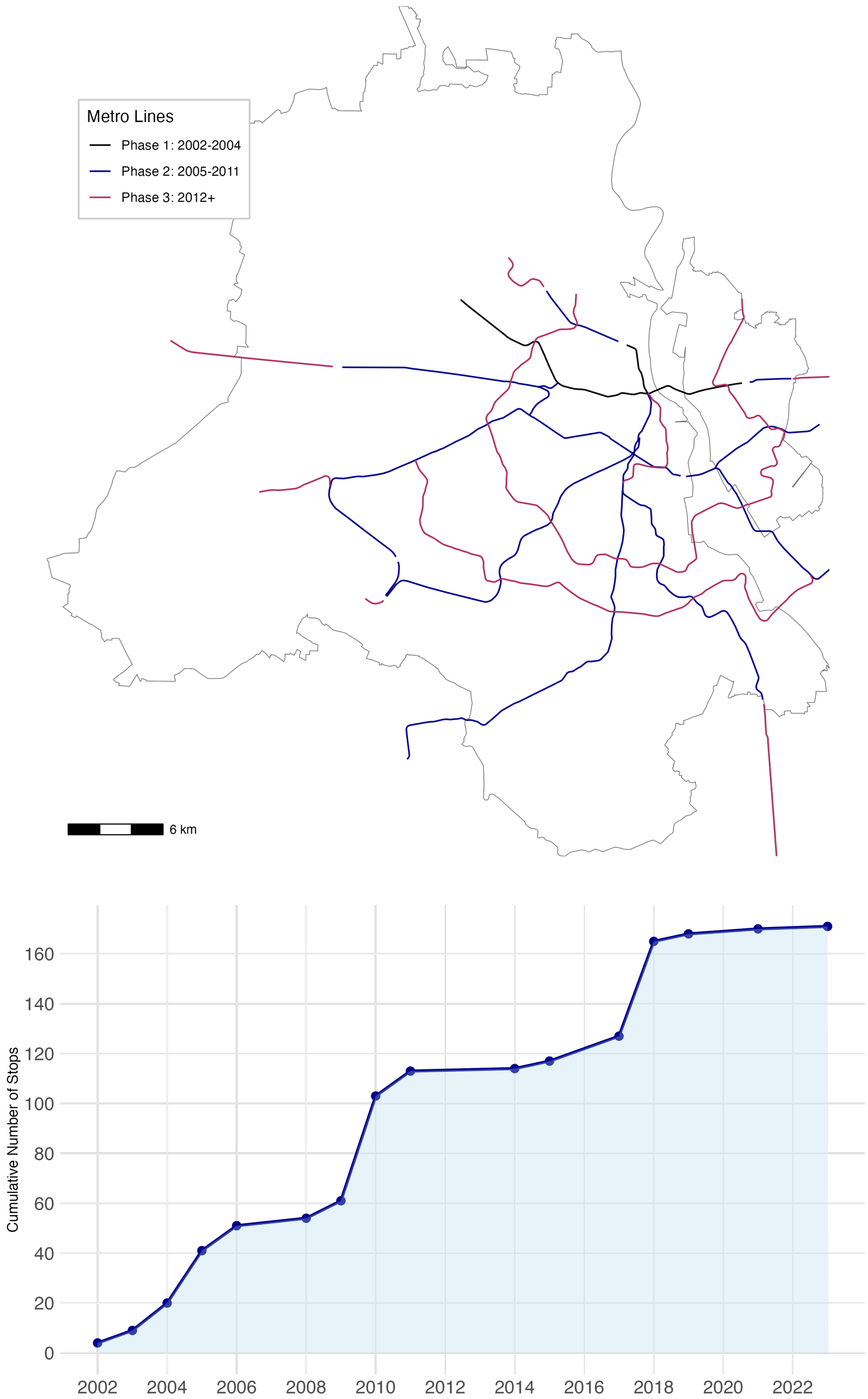
These effects concentrate in peripheral areas of the city, where metro access transforms previously disconnected neighborhoods into new economic hubs. Firm entry near metro stations follows a spatial gradient: while transit proximity yields modest advantages in core areas, the differential impact intensifies with distance from the central business district. Beyond ten kilometers from the city center—where neighborhoods without transit access experience minimal firm entry—transit-adjacent neighborhoods maintain entry rates comparable to levels observed in the urban core. This spatial pattern indicates that transportation infrastructure enables economic decentralization by making peripheral locations viable for firm activity that would otherwise concentrate near the city center.

Methodologically, this study demonstrates the value of combining establishment-level data at fine spatial scales with variation in infrastructure timing. Our approach reveals mechanisms that would remain obscured in aggregate analyses: the systematic sorting of firms by type and size around transit stations, the differential employment responses across worker characteristics, and the spatial redistribution of economic activity toward the urban periphery. These patterns highlight that transportation infrastructure effects extend well beyond traditional commuting benefits captured in most policy evaluations.

The dual-channel framework developed here has important implications for transportation and urban development policy. First, our decomposition results indicate that policies focused solely on improving worker mobility—such as subsidized fares or dedicated transport services for specific groups—may generate limited employment gains if they do not also create demand for labor from employers likely to hire particular types of workers. Second, the concentration of firm entry and employment effects near metro stations suggests that complementary land-use policies—such as relaxing zoning restrictions or promoting mixed-use development around transit nodes—could amplify the employment benefits of infrastructure investment by facilitating the entry of larger, more formal establishments. Third, the peripheral concentration of effects demonstrates that infrastructure investments can serve as catalysts for spatial economic transformation, creating employment opportunities in areas distant from traditional economic centers.

Our findings contribute to understanding how transportation infrastructure shapes local economic development. Rather than simply connecting workers to distant opportunities in city centers, public transit can fundamentally transform neighborhoods by attracting firms that generate new employment locally. This distinction matters for infrastructure planning in rapidly urbanizing developing countries, where investments must both improve connectivity and generate employment growth in peripheral areas experiencing population expansion. Transportation infrastructure, when combined with appropriate complementary policies, can function as an economic development tool that moves opportunity closer to where people live.

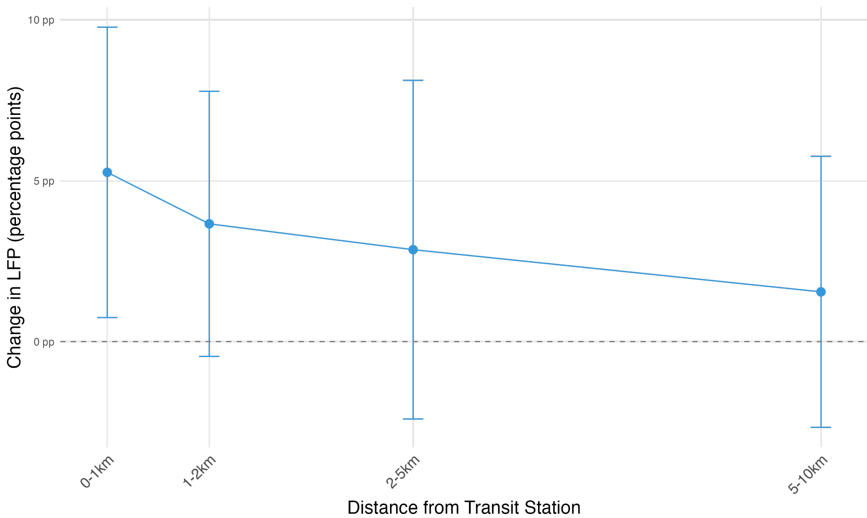
Figure 1: Delhi Metro Network Expansion



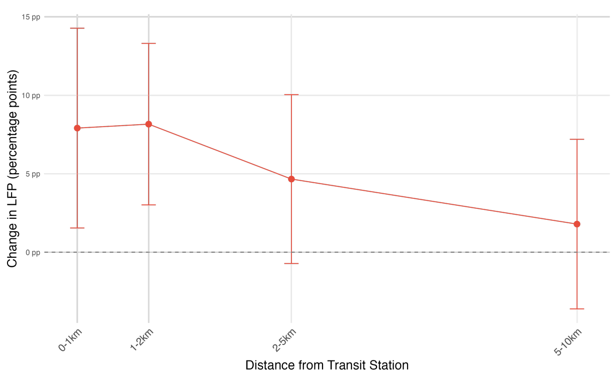
Notes: Panel (a) displays the complete Delhi Metro network as of 2024, showing all operational lines and stations. Panel (b) presents the cumulative number of metro stations over time across the three construction phases.

Figure 2: Labor Force Participation by Distance to Transit Stations

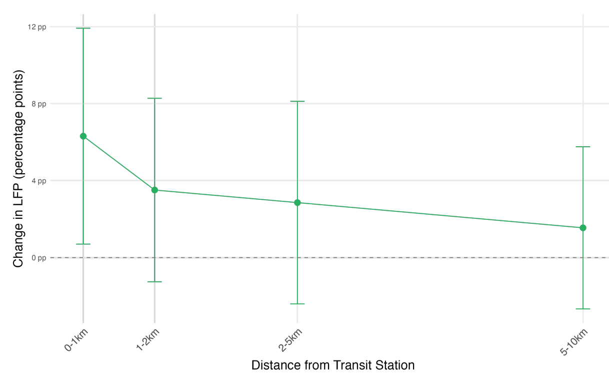
(a) Overall labor force participation



(b) Female labor force participation

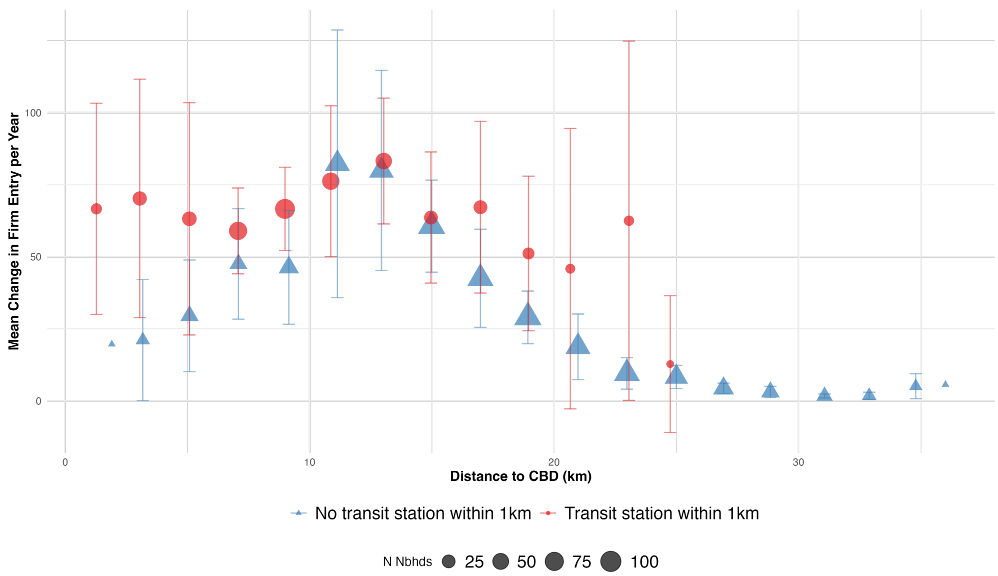


(c) Overall LFP within 5km of CBD



Notes: Estimates of β_1 from equation (1) at varying distance intervals from transit stations. Data: Population Census 1991, 2001, and 2011 at the harmonized 2011 ward level. Sample: wards that eventually received metro stations by 2023. The outcome variable is the proportion of the population in the labor force. Panel A presents estimates for the full sample. Panel B restricts the outcome to female labor force participation. Panel C restricts the sample to wards within 5 kilometers of the central business district. Each point represents the estimated treatment effect ($\text{Treated}_p \times \text{Year2011}_t$) for wards within the specified distance from a Phase 1 or Phase 2 metro station (operational by 2011), with comparison wards beyond that distance. Regressions include ward and year fixed effects, and are weighted by 1991 ward population. Vertical bars represent 95% confidence intervals based on Conley standard errors with a 5km bandwidth to account for spatial correlation. The first metro line became operational in 2002.

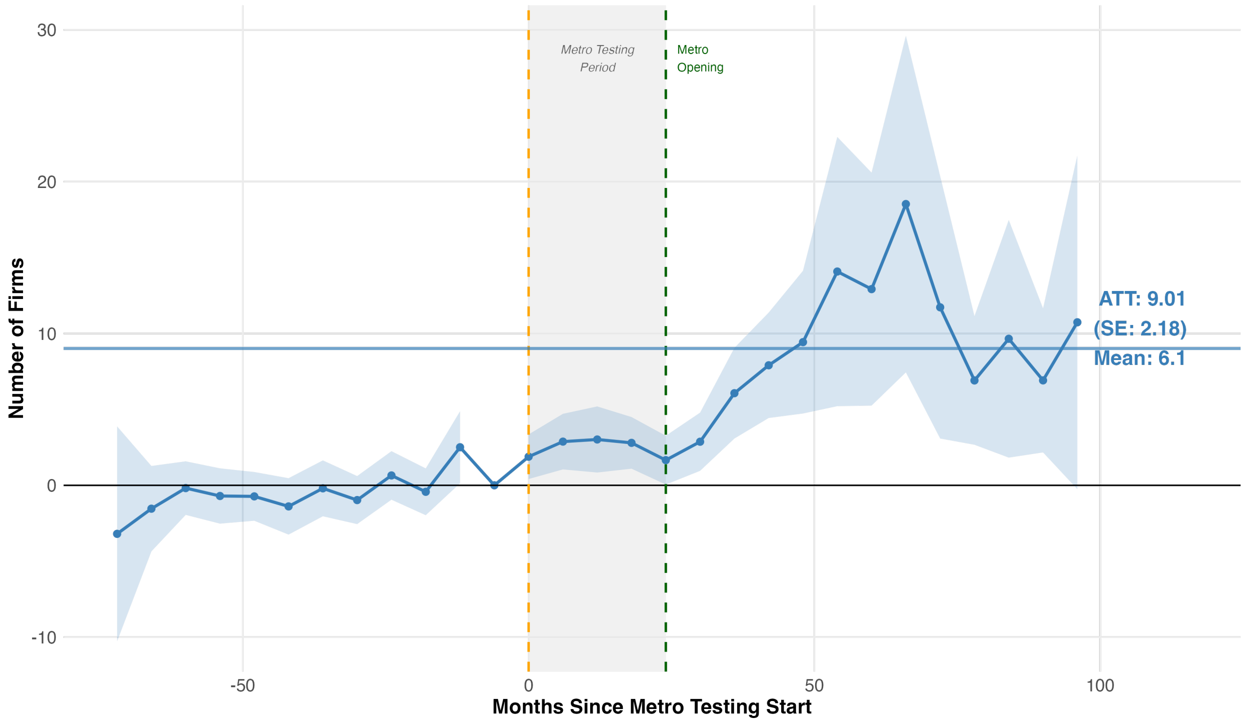
Figure 3: Change in firm entry by distance to city center (moderated by transit access)



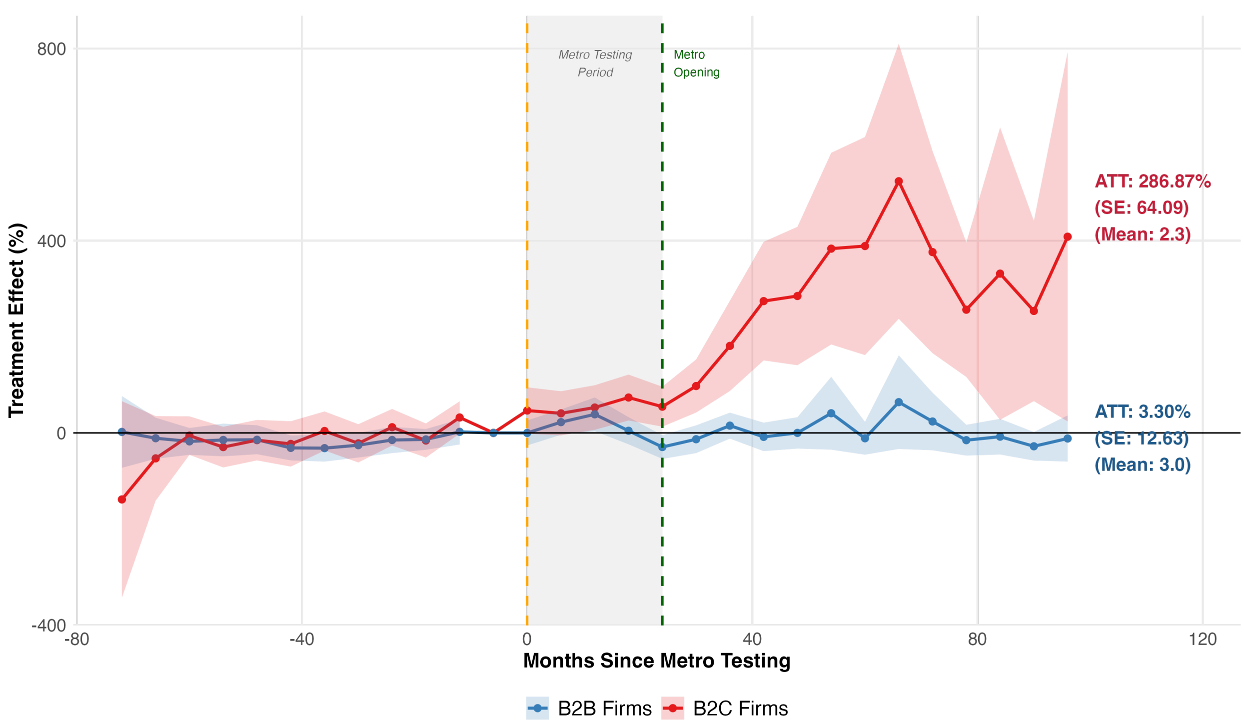
Notes: Binned scatter plot (2km bins). Each point = mean change in firm entry between later (2021-2023) and earlier (2011-2013) period. Red circles: transit station within 1km by 2023. Blue triangles: no transit station within 1km. Size = number of neighborhoods. Error bars: 95% CI.

Figure 4: Firm entries near transit stations

(a) Overall increase in firm entries

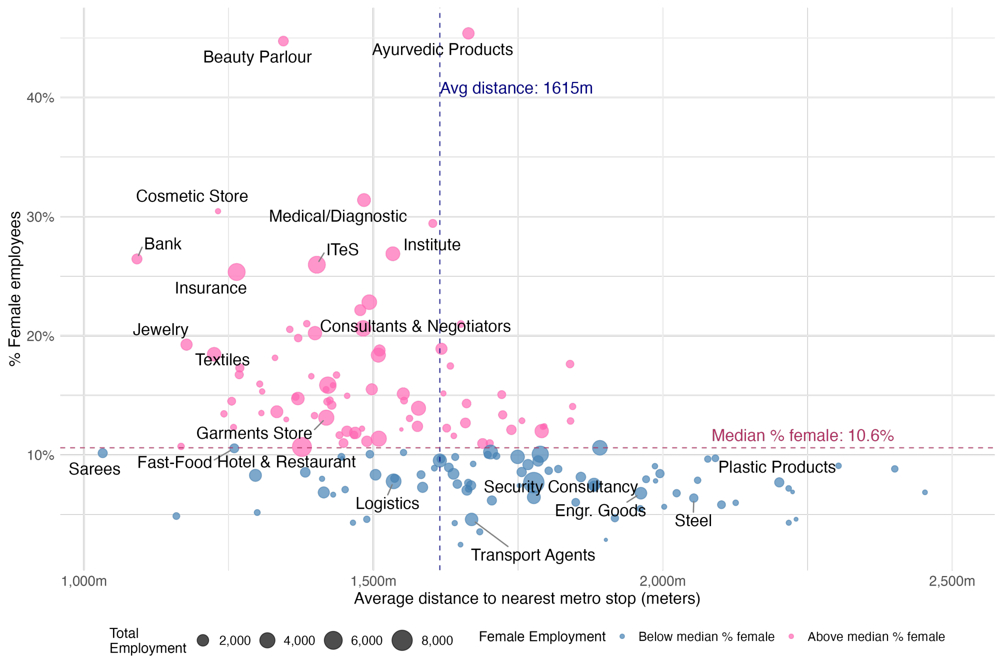


(b) Firm entry by consumer-type



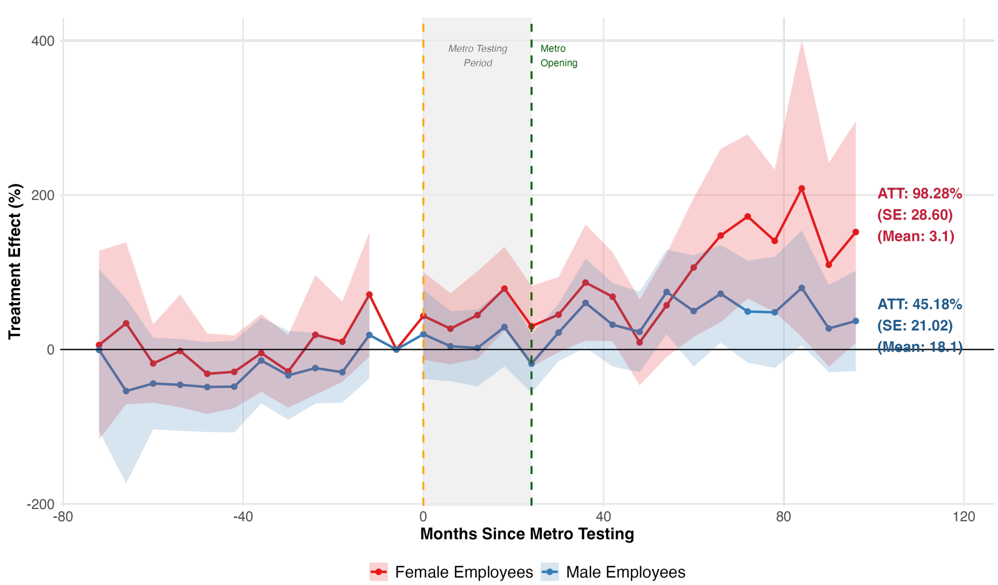
Notes: Staggered DiD estimates (Callaway and Sant'Anna, 2021). Sample: H3 hexagons within 1km of major roads, 6-month periods, 2011-2024. Treatment: transit station within 1km; Comparison: never/not-yet-treated. Shaded: anticipation (4 periods). SE clustered by neighborhood. Panel A: Number of firms. ATT = increase in num. firms; Panel B: Demeaned number of B2C vs. B2B firms (divided by baseline mean of comparison group, 2011-2016). ATT = % change from baseline.

Figure 5: % of industry female, by average distance to transit station



Notes Data: Shop and establishment registrations 2011-2013. Sample includes industries with ≥50 firms and ≥100 total employees from this time period. Each point represents one industry.

Figure 6: Firm Entry near Transit Stations: Female vs. Male Employment



Notes: Estimates from staggered differences-in-differences (Callaway and Sant'Anna, 2021). Data: Shop and establishment registrations 2011-2024; H3 hexagons within 1km of major roads, 6-month periods. Treated: within 1km of transit station; Comparison: never/not-yet-treated neighborhoods. Outcomes normalized by dividing by baseline mean (average across comparison neighborhoods in periods 1-10, 2011-2016); ATT represents % change from baseline. Mean gives is the baseline mean of the original variable. Shaded: anticipation period (4-periods). SE clustered by neighborhood.

Table 1: Entry of firms

	Num. Firms (1)	Firm Size (2)	Num. Spl (3)	Num. B2C (4)	Num. High-Skill (5)	Total Emp (6)
Panel A: Sample - ≤1km from major roads						
ATT	8.91***	0.79***	2.05***	6.66***	-0.00	12.91**
Effect size (%)	143.5%	19.3%	94.6%	280.6%	-0.4%	55.9%
	(2.09)	(0.27)	(0.51)	(1.53)	(0.15)	(5.02)
Mean	6.21	4.12	2.17	2.37	0.75	23.08
Pre-trend p-val	0.221	0.141	0.184	0.466	0.181	0.263
Treated Nbhds	148	148	148	148	148	148
Total Nbhds	633	633	633	633	633	633
Observations	17091	17091	17091	17091	17091	17091
Panel B: Sample - ≤1km from ever-planned transit station						
ATT	6.61*	0.40	1.66**	5.56**	-0.03	7.79
Effect size (%)	67.2%	10.1%	47.2%	148.8%	-2.7%	21.0%
	(3.54)	(0.33)	(0.75)	(2.26)	(0.19)	(6.68)
Mean	9.83	3.99	3.51	3.74	1.14	37.10
Pre-trend p-val	0.179	0.010	0.659	0.418	0.289	0.731
Treated Nbhds	68	68	68	68	68	68
Total Nbhds	193	193	193	193	193	193
Observations	5211	5211	5211	5211	5211	5211
Panel C: Sample - All (excluding always-treated)						
ATT	13.28***	0.58**	2.40***	9.74***	0.15	16.58***
Effect size (%)	326.1%	14.5%	169.3%	626.8%	30.5%	114.3%
	(2.04)	(0.23)	(0.47)	(1.38)	(0.13)	(4.43)
Mean	4.07	3.97	1.42	1.55	0.49	14.50
Pre-trend p-val	0.000	0.310	0.004	0.019	0.287	0.001
Treated Nbhds	178	178	178	178	178	178
Total Nbhds	1573	1573	1573	1573	1573	1573
Observations	42471	42471	42471	42471	42471	42471

OLS estimates of metro station proximity effects on employment and firms. Data: Economic Census from years 1990, 2005, 2013. Treatment: proximity of city wards to Phase 2 metro stations (built 2005-2013). Y2013 interactions = treatment effects; Y2005 = pre-trend tests. Column (1): treated = ≤1km from station, comparison = all areas >2km; sample excludes wards 1-2km from station to account for spillovers. Column (2): treated = ≤1km from station, comparison = ≤1km from unbuilt station; sample excludes wards 1-2km from station to account for spillovers. Column (3): treated = ≤2km from station, comparison = ≤2km from unbuilt station. Column (4): treated = 2-5km from Phase 2 station, comparison = >5km. Column (5): log distance to station specification using all areas. All samples exclude wards ≤1km of Phase 1 metro stations. The mean of the dependent variable is the 1990 value of the respective comparison group (for Column (5) - the sample for the mean is above median distance wards); note that mean reported in Panel B is for average employment. The means are taken from respective comparison samples winsorized at the 95th percentile to account for outliers. All regressions include ward, year×log(distance to CBD), and year×log(distance to Phase 1 metro station) fixed effects. Regressions are weighted by ward area. 5km Conley standard errors in (parentheses). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 2: Effect of Metro Proximity on Stock of Employment and Firms

	(1)	(2)	(3)	(4)	(5)
	Panel A: Outcome = Employment/Population				
Treated=	Metro≤1km	Metro≤1km	Metro≤2km	Metro in 2-5km	Log(Dist)
Comparison=	all	not-yet-built	not-yet-built	>5km	all
Treated×Y2013	0.884*	1.772	0.660*	-0.037	-0.177
	(0.483)	(1.086)	(0.395)	(0.082)	(0.139)
Treated×Y2005	0.252	0.660	0.176	0.054	-0.042
	(0.201)	(0.597)	(0.198)	(0.071)	(0.039)
DepVar Mean (1990)	0.083	0.157	0.184	0.035	0.064
Obs	901	354	675	651	1,139
Wards	349	143	274	248	445
	Panel B: Outcome = Log Average Employment				
Treated=	Metro≤1km	Metro≤1km	Metro≤2km	Metro in 2-5km	Log(Dist)
Comparison=	all	not-yet-built	not-yet-built	>5km	all
Treated×Y2013	0.415***	0.471**	0.332**	0.136	-0.036
	(0.127)	(0.203)	(0.142)	(0.097)	(0.042)
Treated×Y2005	0.059	0.064	0.038	0.295	0.024
	(0.176)	(0.255)	(0.171)	(0.181)	(0.070)
DepVar Mean (1990)	2.740	3.782	3.402	2.346	2.694
Obs	901	354	675	651	1,139
Wards	349	143	274	248	445
	Panel C: Outcome = Share of Large Firms (10+ employees)				
Treated=	Metro≤1km	Metro≤1km	Metro≤2km	Metro in 2-5km	Log(Dist)
Comparison=	all	not-yet-built	not-yet-built	>5km	all
Treated×Y2013	0.052**	0.071**	0.035*	0.013	-0.000
	(0.020)	(0.036)	(0.020)	(0.017)	(0.008)
Treated×Y2005	0.014	0.020	0.015	0.028	0.003
	(0.030)	(0.036)	(0.022)	(0.019)	(0.011)
DepVar Mean (1990)	0.045	0.070	0.055	0.036	0.044
Obs	901	354	675	651	1,139
Wards	349	143	274	248	445

OLS estimates of metro station proximity effects on employment and firms. Data: Economic Census from years 1990, 2005, 2013. Treatment: proximity of city wards to Phase 2 metro stations (built 2005-2013). Y2013 interactions = treatment effects; Y2005 = pre-trend tests. Column (1): treated = ≤1km from station, comparison = all areas >2km; sample excludes wards 1-2km from station to account for spillovers. Column (2): treated = ≤1km from station, comparison = ≤1km from unbuilt station; sample excludes wards 1-2km from station to account for spillovers. Column (3): treated = ≤2km from station, comparison = ≤2km from unbuilt station. Column (4): treated = 2-5km from Phase 2 station, comparison = >5km. Column (5): log distance to station specification using all areas. All samples exclude wards ≤1km of Phase 1 metro stations. The mean of the dependent variable is the 1990 value of the respective comparison group (for Column (5) - the sample for the mean is above median distance wards); note that mean reported in Panel B is for average employment. The means are taken from respective comparison samples winsorized at the 95th percentile to account for outliers. All regressions include ward, year×log(distance to CBD), and year×log(distance to Phase 1 metro station) fixed effects. Regressions are weighted by ward area. 5km Conley standard errors in (parentheses). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3: Effect of Changes in Firm Commuter Market Access on Employment and Firms

Outcomes:	(1) Total Emp (Ward)	(2) Avg Firm Size	(3) Manu Firm (10w+)	(4) High-Skill Firm (10w+)	(5) B2C Firm (10w+)
	Panel A: Firm Commuter Market Access (FCMA)				
$\Delta\ln(\text{FCMA})\times$Y13	1.25**	1.25**	-0.013	0.018***	0.028*
	[16.69%]	[6.60%]	[-0.06pp]	[0.09pp]	[0.14pp]
	(0.562)	(0.593)	(0.041)	(0.006)	(0.014)
$\Delta\ln(\text{FCMA})$ Future$\times$Y13	0.43	-0.20	-0.014	-0.005	-0.011
	(0.939)	(0.991)	(0.034)	(0.006)	(0.008)
DepVar Mean (1990)	3345.371	3.267	0.030	0.006	0.009
	Panel B: FCMA × Above Median Rent				
HighRent$\times$Y13	-0.31***	-0.03	-0.013	0.002	0.002
	(0.108)	(0.156)	(0.009)	(0.001)	(0.002)
$\Delta\ln(\text{FCMA})\times$Y13	1.05**	0.97	-0.011	0.005**	0.019
	[13.79%]	[5.09%]	[-0.06pp]	[0.03pp]	[0.10pp]
	(0.433)	(0.868)	(0.056)	(0.003)	(0.013)
$\Delta\ln(\text{FCMA})\times$HighRent$\times$Y13	0.41	0.70	-0.030	0.046***	0.035***
	[5.20%]	[3.63%]	[-0.16pp]	[0.23pp]	[0.18pp]
	(1.007)	(0.795)	(0.051)	(0.014)	(0.007)
DepVar Mean (1990)	860.298	2.996	0.033	0.004	0.007
	Panel C: FCMA × Has Metro Station in 1km				
Metro$\times$Y13	0.00	0.12	0.003	0.002	0.005***
	(0.226)	(0.146)	(0.008)	(0.002)	(0.002)
$\Delta\ln(\text{FCMA})\times$Y13	0.50	1.74	0.016	0.013*	0.008
	[6.40%]	[9.31%]	[0.08pp]	[0.06pp]	[0.04pp]
	(0.731)	(1.070)	(0.041)	(0.007)	(0.006)
$\Delta\ln(\text{FCMA})\times$Metro$\times$Y13	1.45	-0.78	-0.053	0.011	0.046**
	[19.52%]	[-3.89%]	[-0.27pp]	[0.06pp]	[0.23pp]
	(1.381)	(1.154)	(0.078)	(0.012)	(0.019)
DepVar Mean (1990)	2214.234	3.324	0.036	0.006	0.009
Obs	1,037	1,546,559	1,546,559	1,546,559	1,546,559
Wards	375	375	375	375	375

Poisson (columns 1-2) and OLS (columns 3-5) estimates of firm commuter market access (FCMA) changes on employment and firm composition. Data: Economic Census from years 1990, 2005, 2013. Col (1): total employment at ward level. Col (2): average firm size (employment per firm). Col (3)-(5): binary indicators for firm having 10+ workers in a manufacturing, high-skill professional, or business-to-consumer industry, respectively. $\Delta\ln(\text{FCMA})$ measures log change in firm commuter market access from 2005 to 2013 due to change in metro network. $\Delta\ln(\text{FCMA})$ Future measures anticipated future accessibility gains (2013-2022). Panel B interacts $\Delta\ln(\text{FCMA})\times$Y13 and $\Delta\ln(\text{FCMA})$ Future$\times$Y13 with indicator for ward having above-median rent per sqft (as assessed by city municipality). Panel C interacts $\Delta\ln(\text{FCMA})\times$Y13 and $\Delta\ln(\text{FCMA})$ Future$\times$Y13 with indicator for ward being within 1km of a metro station in 2013. [Brackets] show the predicted effect of moving from the 25th to 75th percentile of FCMA change, which is 0.123 for Col 1 and 0.0512 for Cols 2-5. Effect sizes are in percentage change in the outcome for Poisson models (Cols 1-2), and percentage point change for binary outcomes (Cols 3-5). The dependent variable mean is the 1990 value for the respective control group: Panel A uses wards below median FCMA change; Panel B uses below-median rent wards with below-median FCMA change; Panel C uses wards without metro stations and below-median FCMA change. All regressions include ward and year fixed effects. 5km Conley standard errors in (parentheses). $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 4: Effect of Changes in Firm Commuter Market Access on Employment and Firms

Panel A: Number of New Firms (employment weighted) - contributing to female employment								
	Metro-Type		Manager Gender		Firm Workforce		Firm Workforce	
	(1) High	(2) Low	(3) Female Mgr	(4) Male Mgr	(5) $\geq$ 1 women	(6) No women	(7) Fem-Majority	(8) Male-Majority
ATT (% inc.)	48.8*	35.3	180.0***	46.8*	86.3***	26.4	184.1***	40.9*
	(25.3)	(37.4)	(42.5)	(24.5)	(29.1)	(29.9)	(60.3)	(21.8)
Mean	10.43	7.94	2.62	17.41	11.36	11.72	2.58	20.44
Pre-trend p-val	0.105	0.985	0.478	0.236	0.516	0.193	0.311	0.156
Panel B: Number of Employees in New Firms - female vs. male employees								
	Female Emp		Male-Managed		10w+ Firm		Specialized Firm	
	(1) Gen Prod	(2) Fem Prod	(3) Fem Emp	(4) Male Emp	(5) Fem Emp	(6) Male Emp	(7) Fem Emp	(8) Male Emp
ATT (% inc.)	95.8***	93.0	92.8**	35.7	114.6***	44.4	82.0***	54.2**
	(28.8)	(59.0)	(37.2)	(27.5)	(36.7)	(43.1)	(30.0)	(22.1)
Mean	2.58	0.21	2.07	13.98	1.43	7.23	1.71	8.72
Pre-trend p-val	0.397	0.527	0.538	0.081	0.744	0.535	0.421	0.525
Neighborhoods	370	370	370	370	370	370	370	370
Observations	9990	9990	9990	9990	9990	9990	9990	9990

Outcomes: Panel A (Number of employment-weighted firms that are...): (1-2) in high vs. low metro-propensity industries (3-4) Male vs. female-managed; (5-6) With vs. without female employees; (7-8) Female vs. male-majority workforce. *Panel B (Number of employees):* (1-2) Female employees in female-oriented vs. general industries; (3-4) Female vs. male employees in male-managed firms; (5-6) Female vs. male employees in firms with 10+ workers; (7-8) Female vs. male employees in differentiated firms (owner$\neq$manager). ATT from staggered difference-in-differences (Callaway and Sant'Anna, 2021), multiplied by 100 to represent % change relative to baseline. Date: Shops and Establishment Registrations (2011-2024). Sample is at neighborhood-time level, where, with neighborhoods being H3 hexagons within 1km of major roads and time being 6-month periods. Treatment: metro station within 1km; comparison: never-treated and not-yet-treated neighborhoods within 1km of major roads. Baseline mean is the average raw outcome across comparison neighborhoods (never-treated or first-treated after period 2) during 2011-2016 (periods 1-10). Outcome variables are normalized by dividing by this baseline mean, such that ATT represents % change from baseline. Pre-trend p-value from F-test of 8 pre-treatment periods (months -72 to -30). ATT estimated over 4 anticipation periods, event, and 12 post-opening periods. Standard errors clustered by neighborhood. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 5: Decomposition of Gendered Employment Effects

	Employment Effects by Gender and Sector			
	Male Employment (1)	Female Employment (2)	Female Employment Firm Comp Const. (3)	Female Employment Fem Share Const. (4)
Treated×Y2013	1.4856	0.2860*	0.0693	0.1040*
	(0.9161)	(0.1708)	(0.0496)	(0.0564)
Treated×Y2005	0.5387	0.1217	0.0256**	0.0249
	(0.5072)	(0.0908)	(0.0120)	(0.0198)
DepVar Mean (1990)	0.1437	0.0136	0.0126	0.0120
Observations	354	354	354	354
Wards	143	143	143	143

OLS estimates of metro station effects on employment. Treatment: wards ≤1km from Phase 2 stations (built 2005-2013). Comparison: wards ≤1km from unbuilt stations. Y2013 interactions = treatment effects; Y2005 = pre-trend tests. Sample excludes wards 1-2km from built stations and wards ≤1km from Phase 1 stations. Columns show male employment per capita (1), female employment per capita (2), counterfactual female employment holding firm type distribution constant at 1990 levels (3), and counterfactual female employment holding female shares within firm types constant at 1990 levels (4). Column (3) isolates within-firm-type changes in female hiring by fixing the distribution of employment across industry×size bins at baseline proportions. Column (4) isolates compositional effects by fixing the female share within each industry×size bin at baseline levels. Dependent variable means from 1990, winsorized at 95th percentile. Includes ward FE, year FE, year×controls (log distance to CBD, log distance to Phase 1 stations). Weighted by ward area. 5km Conley SEs in parentheses. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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