Market Power, Commuting Costs and Local Labor Markets*

Sebastián Espinoza-Rojas

University College London, **[Job Market Paper]**

Tristany Armangué-Jubert

Universitat Autònoma de Barcelona, Barcelona School of Economics

Nicolás Herrera La Rotta

University of California Santa Barbara

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Abstract

We study how commuting frictions shape employer market power and how that effect varies by worker skill type. We document that low-skill workers are relatively less mobile, which leads to more segmented labor markets and higher firm labor market power compared to high-skill workers' labor markets. Exploiting the staggered expansion of Santiago de Chile's metro expansion, we estimate effects of improved connectivity on wages, mobility, and wage markdowns. Metro access raises cross-market mobility by 6% over six years, increases local wages by 12%, and compresses markdowns by 5 percentage points on average. Importantly, the reduction is larger for low-skill workers' labor markets, with a decrease of 7.3 percentage points, compared to high-skill workers, whose markdowns fell by 4.8 percentage points. We do not see effects on housing and firm entry, exit and location respond little. We then build a quantitative urban model with oligopsonistic wage posting, heterogeneous agents, residential choice, and multimodal commuting. Calibrated to pre-expansion data, the model shows that faster commutes increase firm-specific labor supply elasticities via expanded market access, and generate welfare and productivity gains, which are larger for low-skill workers.

Keywords: Labor market power; commuting frictions; spatial models; local labor markets.

JEL Classification: **J42, J61, R41, O18**

*Espinoza-Rojas: Department of Economics, University College London, 30 Gordon St, London, WC1H 0AN, UK sebastian.espinoza@ucl.ac.uk, Armangué-Jubert: IDEA, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, 08193, Spain, tristany.armangue@barcelonagse.eu, Herrera: Department of Economics, University of California Santa Barbara, CA 93106, United States jherreralarotta@ucsb.edu. Espinoza-Rojas gratefully acknowledges financial support from the Stone Centre at UCL. All errors are ours.

I. Introduction

In large metropolitan areas, where workers live and how they travel to work determine which jobs are effectively available. Distance, time, and out of pocket commuting costs segment workers across space into local labor markets, some wide and central, others narrow and peripheral. A worker in the outskirts who relies on slow and unreliable public transport does not have access to the same set of employers as a worker in the city center (Redding and Turner, 2015; Manning and Petrongolo, 2017; Zarate-Vasquez, 2022). When labor markets are segmented in this way, workers cannot substitute away from a given employer as easily and local labor supply to each firm is relatively inelastic. In such environments firms have wage setting power and pay wages below workers' marginal revenue products. Commuting costs are therefore a key driver of employer market power in large urban labor markets that result in wage markdowns[1], misallocation of labor, and aggregate losses.

This segmentation of labor markets is not neutral across types of workers. Low skill and low income workers are more likely to live in peripheral or cheaper neighborhoods and to rely more on public transport, particularly in large cities from the developing world. Conversely, higher skill workers are more likely to own cars and live closer to major job centers (e.g. Tsivanidis, 2023; Zarate-Vasquez, 2022; Kreindler and Miyauchi, 2023). Spatial frictions can then widen wage gaps between skill groups and across locations, even when productivity is held fixed, due to different susceptibility to employer market power.

In this paper we study how large public transport infrastructure investments affect labor market power, how different commuting modes endogenously generate gaps between low and high skill workers, and whether a significant decrease in commuting times by public transport can narrow this gap. These questions matter for how we evaluate urban transport policy, for how we measure market power, and for how we understand its role in shaping wage inequality within a city. We study these questions in the context of a large public transport expansion in Santiago de Chile, which substantially reduced travel times. San-

[1] Wage markdowns are defined as the percent gap between a worker's wage and their marginal revenue product of labor.

tiago shares key features with many large cities around the world: it is home to around 8 million people, which is nearly 40 percent of Chile's population, and it features a highly segmented spatial distribution, with high-income residents concentrated in the north-east of the city, and most of the people living in the outskirts. Starting in the early 2000s, the city underwent a major transformation that continues to this day. The expansion connected some of the most populous districts in the periphery, such as San Bernardo and Maipú, to the city center. Between 2005 and 2019, the system grew from four lines covering approximately 41 percent of the population to eight lines covering over 75 percent. This expansion led to a substantive increase in metro ridership, going from 330 million to 703 million annual passengers between 2005 and 2019, and resulted in a significant reduction in commuting times for affected residents.

Thus, we seek to answer three questions. First, how commuting costs and access to jobs relate to the level and spatial pattern of wage markdowns within a city, and how does this relationship differ by skill. Second, how heterogeneous are the effects of reductions in commuting costs across workers with different skills and across markets with different degrees of concentration. Third, what are the welfare and distributional consequences of such changes once we account for the general equilibrium in a spatial urban model with residential and commuting choices.

First, we estimate empirical wage markdowns at the local labor market level, defined as municipality $\times$ industry $\times$ skill in our baseline specifications, following Bassier et al. (2022). In three year rolling windows, we begin by estimating firm log-wage policies in the spirit of Abowd et al. (1999). Then, for each local labor market and using the same three year windows, we estimate separation elasticities by regressing a separation dummy on the estimated firm log wage policy. Since the independent variable of interest is itself an estimate, we split the sample into two groups and use the estimated firm effects of each group as an instrument for the other, as in Goldschmidt and Schmieder (2017) or Bassier et al. (2022). Using the result from Manning (2003), we map the estimated separation elasticity for each local labor market to the labor supply elasticity and the wage markdown. Average markdowns are approximately 30 percent in 2006, meaning that workers are paid 30 percent less than their marginal rev-

enue product of labor, and decline to approximately 25 percent in 2019.

Armed with yearly estimates of wage markdowns at the local labor market level, we proceed with the rest of our empirical analysis. We first find descriptively that low skill labor markets have a more inelastic labor supply and therefore higher markdowns than labor markets for high skill workers. Before the expansion, markdowns in low skill markets are about 7 percentage points higher than in high skill markets. This is in consistent with evidence documenting small elasticities on average for low wage workers (Webber, 2015; Sokolova and Sorensen, 2021; Deb et al., 2024; Yeh et al., 2022). It constrast with Bachmann et al. (2022), who find more monopsony power for non routine cognitive jobs in Germany, and with the evidence of substantial employer power over specialized jobs such as nurses, schoolteachers and tenure track faculty professors (Staiger et al., 2010; Ransom and Sims, 2010; Goolsbee and Syverson, 2023). These differences likely reflect that those studies focus on national or highly specialized labor markets with few relevant employers and salient non wage amenities whereas we study local markets for broadly defined skill markets. Complementarily, we observe that low skill workers are less geographically mobile: around 36 percent of them work in the same municipality where they live, compared to 17 percent of high skill workers. This is in line with results showing that applications and search are very local and that workers tend to work close to their residences (for instance, Manning, 2003; Marinescu and Rathelot, 2018). Before the expansion, wages in the outskirts are on average 23 percent lower than in the city center for low skill workers and 15 percent lower for high skill workers. This implies that low skill workers face larger potential wage gains from relocating to the city center than high skill workers.

We interpret these patterns as evidence pointing in the direction that commuting costs restrict the outside options of low skill workers relatively more and strengthen employer market power in their local labor markets. Taken together, these facts are consistent with commuting costs being an important source of heterogeneity in employer market power across workers and locations and with changes in commuting costs reducing overall market power and having systematic distributional effects.

We then exploit plausibly exogenous differences in stations' staggered opening dates to evaluate the effect of new metro lines on wages, wage markdowns, and job moves across locations. In order to make the argument that differences in opening dates of new stations are exogenous, we select the sample of municipalities that were treated with new metro stations in the years between 2006 and 2019. Therefore, in our baseline specifications throughout, we compare individuals that reside in municipalities that have already received treatment with those that are yet to receive it but will do so before 2019. Our sample relevant sample is then the set of 14 municipalities that did not have a metro station before 2006 but received at least one before 2019.

Using a staggered differences-in-difference, our estimates suggest that new access to the metro network leads to a persistent increase in the yearly probability of switching to a different local labor market of approximately 5 percentage points. Similarly, we find that access to the metro leads to wage increases of up to 30 percent for workers that switch to new labor markets and 15 percent for workers that stay in the same labor market. We interpret the latter as a clear indication of reduced market power of the employers, who now have to compensate their workers with higher wages to avoid them leaving for newly-accessible firms in other local labor markets. Conversely, we find no conclusive evidence of an effect on the number and price of housing transactions or on firm entry, exit or relocation.

Using the same staggered timing, we next estimate the effect of metro access on wage markdowns at the local labor market level. Because markdown estimation requires three year rolling windows and the data are at the local labor market level, we implement a two period, pre and post, difference in differences design with staggered treatment. Treated local labor markets, in municipalities that gain access to the metro network, see a reduction in wage markdowns of approximately 5 percentage points. This is consistent with the finding that wages of workers that gain access to the metro network but do not change their local labor market increase, and with the idea that better commutes expand workers choice sets and improve their bargaining position vis a vis employers. We find that the effect varies by worker skill type. In the case of low-skill labor markets markdowns fall by 7.3 percentage points, while for high-skill workers

fall by 4.8 percentage points. The fall in markdowns is concentrated in previously thin local labor markets. Proxying market size by the number of firms and the number of workers, and interacting it with the treatment dummy, we find that treatment led to a reduction in markdowns of up to 14 percentage points in previously small low-skill markets, and non significant changes in previously large markets.

Lastly, we try to disentangle what fraction of the increase in wages is associated with a decrease in employer market power and what fraction is associated with productivity gains. Our data do not allow us to observe productivity directly, so we use the firm component from the AKM model as a proxy for productivity.[2] We start from the increase in wages estimated in the staggered specification and decompose these gains into changes in markdowns and changes in productivity. We find that around a 38 percent of the wage increases are explained by reduction in market power, while the other 62 percent are explained by increases in productivity.

We further decompose the productivity component into two parts. The first part captures workers moving to ex ante more productive firms when commuting costs fall. Keeping firm ex ante productivity fixed, we ask whether workers move to firms that were relatively more productive before the metro expansion. A positive effect means that workers are reallocating toward more productive firms. The remaining part of the wage gains that is not explained by the decline in markdowns or by reallocation toward ex ante more productive firms is then attributed to other sources of productivity gains, such as workers-firm better matches or decreasing returns to scale. These productivity related channels are the ones usually stressed in the urban literature. Around 13% of the increase in wages is explained by workers moving to previously more productive firms, while the other 47% is explained by other productivity channels.

We also study how this decomposition varies by worker type. For low skill workers, the increase in competition between employers and the associated reduction in markdowns account for a larger share of the wage gains. For high

[2] We can also use the markdown identity $w = Pmg_L \times (1 - \mu)$ to back out Pmg_L given the μ estimated from separation elasticities. Both approaches yield similar results.

skill workers, reallocation to more productive firms and residual productivity gains are relatively more important. This pattern suggests that a central channel through which commuting costs affect the outcomes of low skill workers is by shaping employer market power.

In the second half of the paper, we develop and estimate a quantitative general equilibrium spatial model of a city with multiple locations, an oligopsonistic labor market, heterogeneous workers and firms, and residential and commuting mode decisions. The model combines the structure of spatial urban models (Ahlfeldt et al., 2015; Arkolakis, 2016) with features of models of imperfect competition and strategic wage posting (Card et al., 2018; Berger et al., 2022; Armangué-Jubert et al., 2025). In the model, workers decide where to live, where to work, and how to commute to work. Firms post wages to maximize profits subject to upward sloping labor supply curves and with knowledge of the effect of their own wage setting on the market.

We estimate the model using data for Santiago de Chile before the metro expansion. The estimated model predicts higher wage markdowns for locations with longer commutes to the city center as the outcome of equilibrium interactions of commuting times, wages, amenities, and housing prices. We then use the model for two counterfactual exercises. First, we simulate the effects of the metro network expansion by replacing the empirical commuting time matrices with those observed in 2019. We find wage gains of about 6 percent, which in the model come almost exclusively from reduced wage setting power, with around 1 percent coming from workers moving to higher productivity firms. Distributional analysis of the counterfactual gains shows that low skill workers experience the largest average gains. Their wages increase by around 7.6 percent and their welfare gains are about 34 percent higher than those of high skill workers. Second, we perform an alternative counterfactual that isolates the effect of a reduction in commuting time on wage markdowns by gradually changing the commuting time from a single municipality while holding all others fixed. The results show a significant effect on wage markdowns for the treated municipality and only very small effects in neighboring municipalities due to positive spillovers. Lastly, we perform an alternative counterfactual in which the metro network is expanded to all municipalities. Lastly, we perform an alternative counterfactual

in which the metro network is expanded to all municipalities. In this scenario, wage gains are around 7% larger than in the observed expansion, and low-skill workers have welfare gains that are approximately 42% higher than those of high-skill workers.

Our work contributes to four strands of literature. First, we contribute to the rich literature that examines the effects of transportation infrastructure on economic outcomes. Previous studies have documented that construction of major transportation systems influence housing prices (Gibbons and Machin, 2005; Billings, 2011), urban population patterns (Baum-Snow, 2007; Gonzalez-Navarro and Turner, 2018), and labor market outcomes such as the spatial separation between workplaces and residences (Heblich et al., 2020), effects on employment and productivity (Gibbons et al., 2019; Tyndall, 2021) and on informality (Zarate-Vasquez, 2022). For instance, in a related paper, Tsivanidis (2023) develops a quantitative spatial model to evaluate the effects of the introduction of a large Bus Rapid Transit system in Bogotá, Colombia, and documents that the new infrastructure reshaped the city's structure and increased welfare by increasing both workers' access to jobs and firms' access to workers. We contribute to this literature by introducing a new channel that goes beyond the productivity gains and workers resorting that has been highlighted in this literature. We also add evidence on distributional effects of such policies.

Second, we contribute to the quantitative spatial equilibrium literature. A growing body of work develops general equilibrium spatial models to explain the determinants of the spatial distribution of economic activity (Ahlfeldt et al., 2015; Arkolakis, 2016; Dingel and Tintelnot, 2020; Monte et al., 2018; Allen and Arkolakis, 2022; Nagy, 2023). This framework has been extended to analyze the welfare impacts of transportation networks (Heblich et al., 2020; Severen, 2023; Allen and Arkolakis, 2022; Fajgelbaum and Schaal, 2020; Tsivanidis, 2023; Zarate-Vasquez, 2022; Greaney et al., 2025). Most of these models assume perfect competition in labor markets (Redding, 2024; Allen and Arkolakis, 2025). However, the presence of additional market frictions can alter the predictions of canonical spatial models, for instance, Vitali (2024) shows that consumer information frictions can alter the firm location decisions and Lindenlaub et al. (2024) develop a model in which firms sort spatially into local labor markets,

and within those markets search frictions generate firms monopsony power. In our model, we introduce oligopsonistic firms and commuting frictions; limited worker mobility gives rise to local wage markdowns. We complement prior work by quantifying how improvements in transit connectivity raise welfare not only through reallocation and better access to jobs, but also via reduced monopsony distortions, all while modeling endogenous responses in labor and housing markets. Our measure of market power is then sensitive to cities' internal structure and infrastructure investments.

Third, we contribute to the growing literature on market power in labor markets. Existing empirical evidence documents widespread employer wage-setting power (Sokolova and Sorensen, 2021; Manning, 2021), yet typically abstracts from documenting the precise sources of that power (Azar et al., 2022; Staiger et al., 2010; Goolsbee and Syverson, 2019; Tortarolo and Zarate, 2018, among others). Theoretical models that address wage-setting power fall into two main traditions: the dynamic monopsony literature, which follows Burdett and Mortensen (1998) and emphasizes search frictions and on-the-job mobility (Jarosch et al., 2024; Rudanko, 2023), and the neoclassical monopsony tradition, which features differentiated firms and idiosyncratic worker preferences over employers (Card et al., 2018) to generate upward-sloping labor supply curves, whether monopsonistic or oligopsonistic (Berger et al., 2022; Armangué-Jubert et al., 2025). Our framework is squarely in the latter tradition. We advance this literature by making location and commuting frictions explicit and measurable sources of firm differentiation that generate market power, while also incorporating workers' endogenous residential decisions and multimodal commuting. This uniquely connects the market power literature to urban and transport economics by showing that reductions in spatial frictions, such as new transit links, raise the elasticity of labor supply and reduce markdowns. Finally, we connect to the literature discussing the distributional implications of monopsony (Eeckhout, 2024; Deb et al., 2024; Kline, 2025) by quantifying how much reductions in markdowns contribute to wage gains at the bottom of the distribution.

Lastly, we contribute to the incipient literature on local labor market power and commuting costs (Vial Lecaros et al., 2023; Datta, 2024; Manning and Petrongolo, 2024). We show that a reduction in spatial frictions not only weakens local

market power, but its impact is most significant for low-skill workers, providing a novel distributional analysis by worker skill type. We also offer direct empirical evidence on the effect on wage markdowns, allowing us to cleanly isolate the market power channel. Crucially, we introduce a new level of spatial detail by being the first to embed oligopsonistic competition in a fully quantitative spatial equilibrium model that features endogenous residential choice, multimodal commuting, and worker heterogeneity. This comprehensive framework allows us to measure distributional effects across workers and localities and evaluate citywide transit expansion counterfactuals.

To our knowledge, we are the first to embed oligopsonistic competition in a quantitative spatial equilibrium model that also features endogenous residential choice, multimodal commuting and worker skill types, and to use it to understand the relation between market power, commuting and skills, evaluate a citywide transit expansion, and explore distributional heterogeneities.

II. Institutional Setting

A. Urban and Labor Market Geography of Santiago

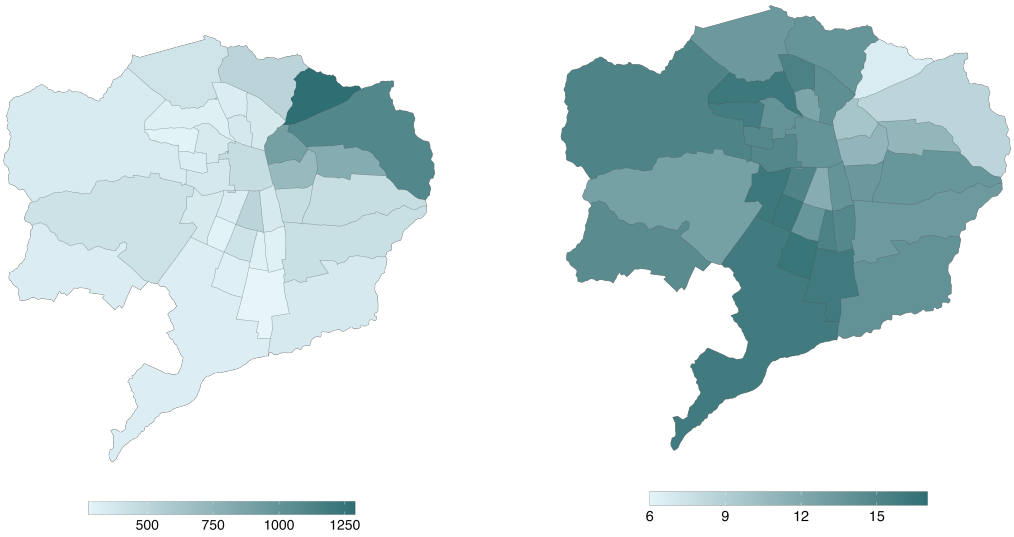
The Santiago Metropolitan Region is home to over 40 percent of Chile's population, or around 8 million people, and accounts for 45% percent of Chile's GDP (Banco Central de Chile, 2024).[3] The Metropolitan Region comprises 52 municipalities, each governed by its own mayor and municipal council, forming a contiguous commuting zone within which people regularly travel across municipal boundaries for work and services.

As in many Latin American metropolitan areas, Santiago exhibits pronounced spatial heterogeneity in labor market outcomes. High-wage jobs are concentrated in the northeastern financial and business districts (Las Condes, Vitacura, and Providencia), whereas low-wage employment is more prevalent in the urban periphery (see Figure 1.a). In contrast to many other Latin American cities, more than 80 percent of workers in Santiago are employed in the formal sector

[3]Oficially: Región Metropolitana de Santiago. Throughout the paper we refer to "Santiago" as shorthand for the entire Santiago Metropolitan Region.

(Ministerio del Trabajo y Previsión Social, 2024). Nevertheless, there remains substantial spatial variation in labor market transition rates across municipalities (see Figure 1.b), with residents of less affluent areas exhibiting a higher likelihood of moving to a different labor market defined as a mix of municipality of residence, sector and skill type.[4] These disparities extend into the housing market: prices per square meter in affluent municipalities exceed those in poorer ones by more than a factor of two.

Figure 1: Spatial Distribution of Labor Market Outcomes in the Santiago Metropolitan Region, 2003–2005



(a) Average Nominal Wage (US Dollars)

(b) Percentage of Workers Transitioning to a Different Labor Market

Notes: The igure displays labor market outcomes across municipalities in the Santiago Metropolitan Region between 2006 and 2009. Panel (a) shows the average nominal wage of residents in each municipality, expressed in U.S. dollars. Panel (b) shows the percentage of workers residing in each municipality who transitioned to a different labor market during the same period.

[4]Economic sectors are classified into 5 categories: agriculture, mining, manufacturing, construction and services. There are two skill type: college and non-college graduates.

B. The Santiago Metro

The Santiago Metro is a rapid transit network and the second largest metro system in Latin America, with a total length of 149 kilometers (92.6 miles). As of 2024, it carries an average of 2.3 million passengers per weekday and serves 27 of the 52 municipalities in Santiago (Metro de Santiago, 2024). The system continues to expand, with ongoing projects expected to extend the network to 225 kilometers by 2033. The current fare structure differentiates prices by time of day (peak and off-peak), inter-modal transfers, and offers discounts for students and senior citizens.

The first metro line was inaugurated in 1975, though proposals for an urban rail network in Santiago date back several decades. The administration of Eduardo Frei Montalva approved the 1968 *Plan Regulador de Transporte de Santiago*, which envisioned five subway lines totaling roughly 80 km (Biblioteca Nacional de Chile, 2025). The plan established two main axes (running north–south and east–west) complemented by transversal lines connecting other parts of the city. Although later expansions largely responded to demographic changes, political and macroeconomic constraints influenced their timing. For example, Line 3, originally part of the 1968 blueprint, was postponed due to the economic crises of the early 1980s and the 1985 earthquake, and only entered service in 2019.

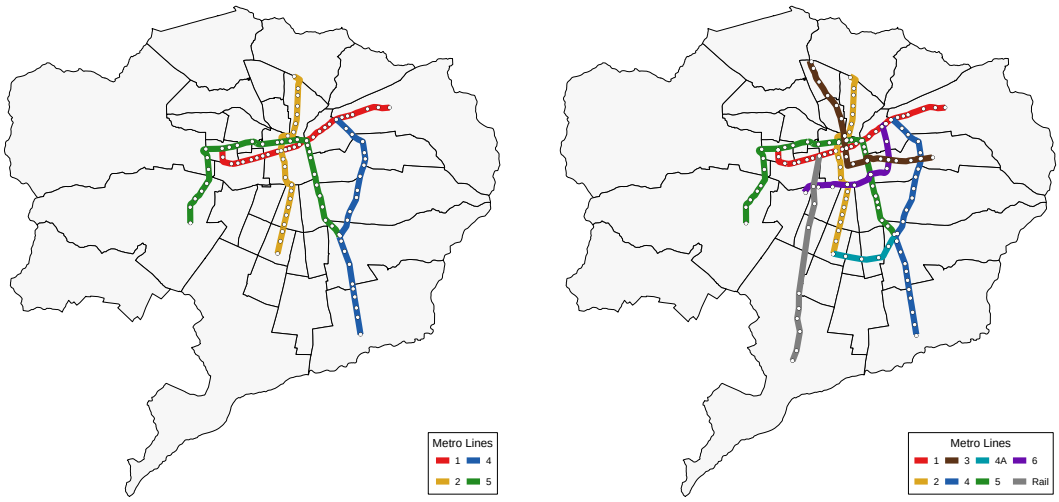
Between its inauguration in 1975 and 2005, the metro system consisted of four lines that connected 13 municipalities, covering roughly 41% of the metropolitan population (see Figure 2.a). Beginning in 2006, three new lines, along with several extensions and a suburban rail system, were constructed to relieve congestion on existing corridors and to extend service toward denser peripheral areas. By 2019, the network reached 28 municipalities, including Maipú and San Bernardo, two of the most populous municipalities before their inclusion in the system, thereby serving nearly 75% of the regional population.[5]

A major structural reform took place in 2007 with the implementation of Transan-

[5]Population data up to 2005 are based on the 2002 Census, while data for 2019 come from the 2017 Census (see Figure 2.b). The share of the metropolitan population living in municipalities connected to the metro by 2005 declined by six percentage points by 2017, whereas the population of municipalities connected after 2005 grew by 15 percentage points.

tiago. Prior to this reform, the bus system was operated by numerous private companies that competed for passengers and was not integrated with the metro network. Consequently, users had to choose between transport modes to avoid incurring higher monetary costs (Figueroa, 2013). The integration of the bus network with the metro system, together with the introduction of free intermodal transfers, led to a sharp increase in metro ridership: the number of trips almost doubled, from 331 million in 2006 to 600 million in 2007 (Metro de Santiago, 2008). According to the Origin–Destination surveys, following the network's expansion and the integration of Transantiago, the share of workers commuting by metro rose from just over 8% in 2006 to 27% in 2012.

Figure 2: Metro Network Expansion



(a) Network in 2005 (b) Network in 2019

Notes: This figure shows a map of the metro and suburban rail system in the Metropolitan Region of Santiago at two points of time: 2005 and 2019.

III. Data

Our analysis draws on multiple administrative datasets that provide detailed information on workers, firms, public transit infrastructure, and the housing market in Santiago. These data allow us to examine how wages, worker mobility, and labor market power evolved in response to the expansion of the metro

and suburban train networks.

A. Employer–Employee Administrative Records: Unemployment Insurance System

The primary dataset is a random sample covering 20 percent of Chile's formal private-sector workforce at a monthly frequency. The data originate from the administrative records of the Unemployment Insurance system. Focusing on Santiago, we observe approximately 85,000 monthly worker–firm pairs. The sample is representative of the population in 2022, and workers' employment histories are tracked both backward and forward from that reference year. Crucially, the dataset includes both residential and workplace locations, enabling us to map local labor markets and assign treatment status based on either the municipality of residence or employment. It also contains unique identifiers for both workers and firms, allowing us to estimate wage markdowns from separation elasticities following Bassier et al. (2022). We observe each worker's monthly nominal wage, education, gender, age, and the firm's industry classification. Our sample consists of workers who were employed for at least six months within a calendar year. For these workers, we average monthly wages within each calendar year to smooth short-term fluctuations and express them in real terms using 2012 prices.

B. Geocoded Santiago Metro and Rail Network Data

We compile geocoded data on metro and suburban train stations, including their precise coordinates and the date when each began operating. From these data we delineate treatment zones (municipalities or neighborhoods that gain access to new metro or train lines during the sample period) and control zones (those that remain unconnected). This spatial-temporal variation enables us to compare outcomes across places with and without network access over time.

C. Commuting Patterns: Origin–Destination Survey Data

We use Santiago's metropolitan origin–destination (OD) surveys from 2006 and 2012, which collect detailed trip diaries and respondent characteristics representative at the district or zone level. For each trip, the data include the origin

and destination, travel time, travel mode (e.g., public or private), trip purpose (e.g., work, school, shopping, etc.), and individual attributes such as age, sex, and education. Using the education level, we construct a college-degree indicator to classify workers by skill type. We restrict the sample to work-related trips and compute: 1) OD flows by zone pair, mode, and worker type, 2) travel times by mode-specific OD pair, and 3) mode shares by OD and worker type. All aggregates are weighted using the survey expansion factors. To avoid post-treatment bias, we define treatment intensity using pre-expansion generalized travel times computed on the pre-expansion network. We calculate the least-cost (time) paths between origins and the city center, as well as between all OD pairs, and measure the change in shortest-time paths implied by adding the new metro links. These pre-period measures yield predicted travel-time reductions for each OD pair.

D. Housing Market Data: Property Registry and Tax Records

We use property cadaster data from the Internal Revenue Service (SII), which provides detailed information on the entire stock of real estate properties in Santiago, including physical characteristics such as floorspace and location. We match these records to the Property Sale and Registration Declarations (Form 2890), which capture nearly the universe of property transactions, reporting sale values and exact transaction dates.[6]

E. Firm Registry Data and Manufacturing Panel

We leverage two complementary firm-level data sources. The annual SII firm registry, which covers the complete universe of registered firms. The SII provides, for each firm–year: harmonized economic activity codes, sales brackets, headcount of workers, establishment location, and other firm characteristics. It does not report worker wages or payroll by skill. We employ the SII data to estimate firm-level regressions connecting metro expansion exposure to outcomes (employment, number of establishments, sales) and to spatially aggregate firm

[6]The transaction date corresponds to the signing of the deed. All transaction values are expressed in Unidades de Fomento (UF) an inflation-indexed unit of account whose peso value is adjusted daily to preserve real purchasing power.

activity to build pre-period baselines.

The ENIA panel from the national statistics office offers richer firm-level detail (for the manufacturing sector) on output, sales, value added, intermediate inputs, capital proxies, and labor disaggregated by skill (e.g. college vs. non-college). Because ENIA only records a city indicator (not exact addresses), we use it for model calibration rather than spatial reduced-form analysis. In particular, we compute factor cost shares and skill-labor shares to calibrate CES production parameters and share parameters for high- and low-skill labor (details are deferred to Section VI).

F. Household Surveys: Socioeconomic Characteristics and Expenditures

We incorporate two nationally representative household surveys. The CASEN survey ("Encuesta de Caracterización Socioeconómica Nacional") is Chile's main nationally representative household socioeconomic survey, conducted every two to three years. CASEN provides rich information on demographics, education, and household composition. Because CASEN is not linked to employers, we use repeated cross-sections to recover population shares relevant for calibration and validation exercises: 1) skill shares, 2) residential population by skill, and 3) car-ownership shares by skill.

The EPS survey ("Encuesta de Presupuestos Familiares") provides nationally representative data on household expenditures. We use EPS to obtain expenditure shares, focusing on car-related spending (vehicle ownership and operation, fuel, parking) as a cross-check on generalized travel costs and income gradients in transport expenditure. These budget shares serve as consistency checks for the implied value of time and for the calibration of generalized transport costs.

IV. Empirical Strategy

A. Markdowns

We estimate empirical markdowns following Bassier et al. (2022). This method follows the result discussed in Manning (2003), which shows that in the steady state the labor supply elasticity to the firm is approximately equal to two times

the separation or recruitment elasticities. Several papers have used recruitment or separation elasticities to estimate wage markdowns (see for instance Dube et al., 2016, 2019, 2020; Dal Bó et al., 2013; Belot et al., 2019). We follow the novel approach proposed in Bassier et al. (2022) closely. First, we estimate the firm component of wages using an AKM (Abowd et al., 1999) specification on monthly wages. Second, we estimate the elasticity of separations with respect to firm wage policies, isolating firm-driven wage variation. Finally, we map the separation elasticity into the firm-specific labor supply elasticity and implied markdowns using the steady-state result in Manning (2003).

Step 1: Firm wage premia (AKM). Let i index workers, j employers, and t years. We estimate

$$\ln w_{ijt} = \alpha_i + \phi_j + \mathbf{x}_{it}'\beta + \varepsilon_{ijt}, \tag{1}$$

where w_{ijt} is the wage of the worker i in firm j and time t, α_i and ϕ_j are worker and firm fixed effects, and $\mathbf{x}_{it}$ includes workers characteristics. To address the generated-regressor problem and potential attenuation when $\hat{\phi}_j$ is used on the right-hand side, we adopt the split-sample IV approach of Bassier et al. (2022). We randomly partition workers into A and B (stratifying by movers), estimate $\hat{\phi}_j^A$ and $\hat{\phi}_j^B$ separately, and instrument own-sample $\hat{\phi}_j^A$ with the complement sample $\hat{\phi}_j^B$ in the separations regression below.[7]

Step 2: Separations responses to firm wage policy. Let $s_{ijt} \in \{0, 1\}$ indicate whether worker i separates from firm j in time t. The object of interest is the semi-elasticity of separations to the firm component of wages, i.e., $\zeta \equiv \frac{\partial \mathbb{E}[s_{ijt}]}{\partial \phi_j} \frac{1}{\bar{s}}$, where $\bar{s}$ is the sample mean separation rate. We estimate ζ in two complementary designs:

AKM-based design. We run the following firm-effect regression:

$$s_{ijt} = \gamma_t + \theta \hat{\phi}_j^A + \mathbf{Z}_{it}'\delta + u_{ijt}, \tag{2}$$

[7] Split-sample IV yields strong first stages and removes mechanical correlation between a worker's separation and the regressor. For a detailed explanation see Bassier et al. (2022).

and instrument $\hat{\phi}_j^A$ with $\hat{\phi}_j^B$ (the split-sample estimate). The elasticity is $\hat{\zeta} = \hat{\theta}/\bar{s}$. For identification, we require that variation in $\hat{\phi}_j$ captures wage policies rather than sorting on unobservables; split-sample IV plus rich worker-history controls and trimming of the extreme 2.5% tails of $\hat{\phi}_j$ mitigate ecological bias.[8]

Matched event-study IV around job moves. Focusing on movers $O \to I$, let us define $\Delta \ln \bar{w}_I - \Delta \ln \bar{w}_O$ as the change in the firm-average wage faced by otherwise similar workers who happened to join different I-firms at the same time. Then, we can use this firm-level change as an instrument for the worker's own wage change $\Delta \ln w_{i,t+1}$ and estimate the re separation response over the subsequent t_k years with rich origin-firm wage/tenure histories and calendar-time fixed effects:

$$s_{i,t+k} \;=\; \eta_k \widehat{\Delta \ln w}_{i,t+1} \;+\; \lambda_k(\text{History}_{i,O}) \;+\; \vartheta_k \;+\; \epsilon_{i,t+k}. \tag{3}$$

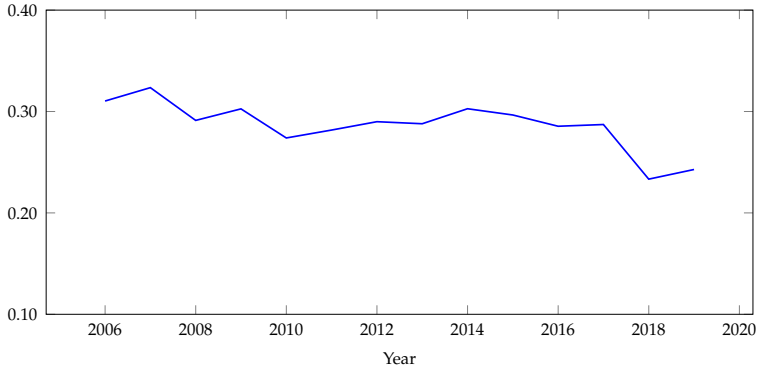
Pooling over k yields a (LATE) separations elasticity $\hat{\zeta}$ that is robust to match effects and unobserved sorting and closely matches the AKM-based estimate.

Across designs, we express estimates as elasticities, measured as the coefficient divided by the relevant mean separation rate. Bassier et al. (2022) verify the steady-state assumption by comparing firm-level separations and recruits; in practice these lie close to the 45° line. We do not have information regarding recruits so cannot implement such checks.

Step 3: From separations elasticity to labor supply elasticity and markdowns. We use the results in Manning (2003), that show that there exists a direct mapping between separation elasticities and the firm-specific labor supply elasticity (and to the recruitment elasticity). Even when allowing for job-to-job recruits explicitly, their estimates are numerically very close to doubling the separations elasticity.

[8] Bassier et al. (2022) show OLS of s_{ijt} on $\hat{\phi}_j$ is sensitive to worker sorting; instrumenting own-sample firm FE with complement-sample FE restores a large negative slope (separations elasticity around -1.4). They trim 2.5% tails of $\hat{\phi}_j$ and cluster at the firm level.

Figure 3: Average Markdown per year



NOTES: Average markdowns per labor market-year using the split-sample IV approach. Labor markets are defined by municipality or origin, economic sector and skill. Economic sectors are classified into 5 categories: agriculture, mining, manufacturing, construction and services. There are two skill type: college and non-college graduates.

Given $\hat{\varepsilon}_j$, the implied markdown is

$$\mu_j \equiv \frac{\text{MPL}_j - w_j}{\text{MPL}_j} = \frac{1}{1+\hat{\varepsilon}_j}. \tag{4}$$

We report $\hat{\mu}_j$ at the market level. Figure 3 summarizes the average markdown per year in our sample. It can be seen that our estimation of markdown is around 0.28 before the metro expansion, which is equivalent to a labor supply elasticity to the firm of around 2.57. Our estimation is close to the recent literature (see for instance, Armangué-Jubert et al., 2025). Bassier et al. (2022), whose strategy we follow, finds an elasticity of around 3 to 4 overall for the US.

B. Empirical Strategy

We exploit the staggered expansion of the Metro network as plausibly exogenous variation in commuting costs to study impacts on labor and housing markets, firm outcomes, and commuting decisions. Conditional on eventual treatment during 2006–2019, we argue that the within-wave timing of station openings is close to random. Accordingly, we compare individuals living in municipalities that have already received a new station with individuals in municipal-

ities that have not yet been treated but will be in the near future (our preferred counterfactual). A *treated* municipality is one that had no Metro station previously and receives its first station at time $t \in \{2006, ..., 2019\}$.

We also consider two alternative control sets: (i) *never-treated* municipalities, that may be useful as an external reference; and (ii) municipalities with low exposure in the relevant wave. Following the recent difference-in-difference literature, we implement the imputation estimator of Borusyak et al. (2024) as our baseline and check robustness using Callaway and Sant'Anna (2021) and a conventional event-study specification. The results remain qualitatively consistent under these different specifications.

A standard concern is that infrastructure placement reflects unobserved local fundamentals. We argue in Section II that, conditional on being included in the expansion window, the timing is orthogonal to those fundamentals. A feature of the historical metro development is that core central areas were connected earlier, so later rollout disproportionately benefited more peripheral locations, reducing the risk that "high-powered" downtown neighborhoods drive the results.

A further concern is that the aggregate spatial equilibrium may shift as the network expands, potentially affecting untreated and not-yet-treated areas. We cannot completely rule out such effects. However, the staggered treatment mainly occurred on the urban periphery, making it unlikely that workers in other untreated areas would commute to take advantage of those improvements before local access was available. These potential general-equilibrium effects are one reason we develop our structural spatial model.

Our event-study equation relates outcomes y_{immt} of worker i living in municipality m at time t to the k periods since the event.

$$y_{imt} = \alpha + \sum_{k=-T} \beta_k T_m^k \mathbf{1}[t = k] + \sum_{k=0}^{T} \beta_k T_m^k \mathbf{1}[t = k] + \phi_t + \phi_i + \gamma X_{it} + \varepsilon_{imt}$$

Where ϕ_t and ϕ_i are time and individual fix effect, and X_{it} is a set of individual and firm level controls, $\| > 0$ are leads and $\mathcal{K} < 0$ are lags.

V. Reduced Form Results

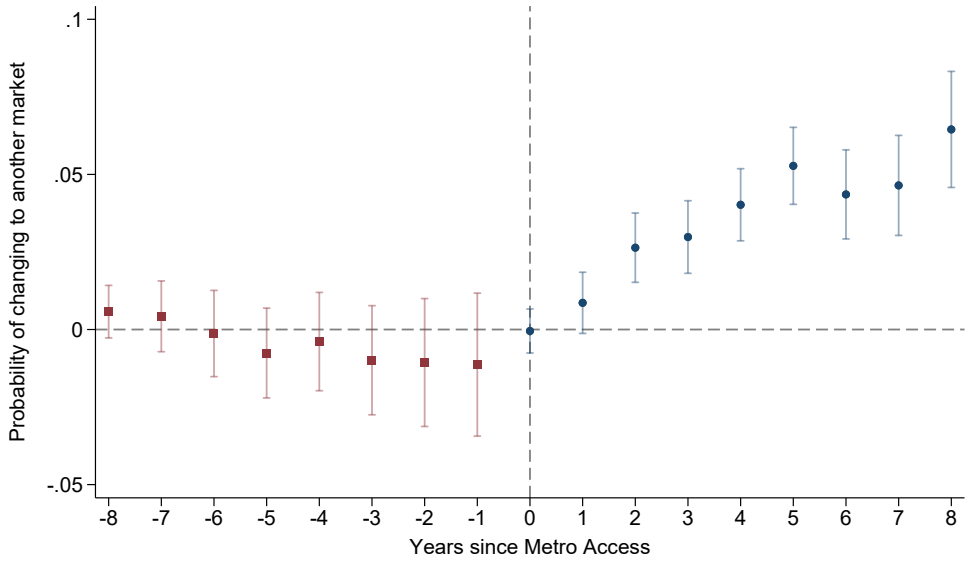
A. Cross Market Mobility

We find evidence that workers' cross market mobility increased after the reduction in commuting costs. We can see this in two ways. First, when we use our staggered difference-in-differences approach, we find that the probability of working in a different market than the last period increased by approximately 1 percentage point following the opening of a new metro line, and continued to increase up to 5 percentage points 6 years after (see Figure 4). The gradual increase in this probability likely reflects the fact that a job-switch is required to change to another local labor market and that workers slowly phased out of previous contractual arrangements before enjoying the larger effective choice set that resulted from the reduced commuting costs. The coefficient remains positive over time, indicating that workers continue to be more likely to change markets after the expansion, rather than returning to pre-opening mobility levels. This sustained effect suggests a lasting increase in cross-market mobility following the reduction in commuting costs. The results are qualitatively robust to the use of the estimator proposed by Callaway and Sant'Anna (2021) and the standard dynamic event study.

Second, workers also travel more outside their localities as a result of new metro access. Using the Origin Destination surveys, we estimate a static difference in differences specification and find that metro access increases the probability of traveling outside the origin locality to work by about 26 percentage points. The response is stronger in municipalities that experience larger reductions in travel time, and a ten percent decrease in travel time is associated with an increase of roughly eight percentage points in the probability of working outside the origin locality (see Table 2). These results are consistent with workers taking advantage of a larger effective choice set once commuting costs fall.[9]

[9]Because Origin Destination surveys are not available annually, we estimate a static stag-

Figure 4: Cross Market Mobility and the metro network expansion



NOTES: The figure displays the results of the dynamic event-study specification, with cross-market mobility as the dependent variable and time to the introduction of the metro in the municipality as the explanatory variable of interest. Labor markets are defined as municipality, sector and skill level (college and no-college). Standard errors are clustered at the municipality level.

The effects on cross-market mobility are similar across genders and education levels, and higher for younger workers than for older ones. Workers between the ages of 18 and 30 see their probability of changing local labor markets increase relatively more after the introduction of a new metro line than workers in later ages (see Appendix A).

B. Wages

Workers' wages increase as a result of gaining access to the expanded metro network. This effect holds regardless of whether workers transition to jobs in newly connected labor markets or remain employed within their original markets. Among workers who move to new labor markets, wages rise by approximately 5 percent one year after the metro's implementation. Consistent with the mobility patterns described previously, wages continue to grow, increasing by an average of about 25 percent five to seven years after the metro expansion in their area of residence (see Figure 5(a)). This increase may arise from better matching with firms or workers gaining access to more productive firms. Complementarily, workers that stay in the same labor market see an increase of around 12% after 5 years of the introduction of the new metro line.

We conjecture that the wage increase among stayers is partly driven by an increase in competence, which in turn implies a reduction in local labor-market markdowns. As local firms face greater competition from other firms that became more accessible, they are likely to raise wages to retain their workers. The magnitude of the wage increase is consistent with our estimated decrease in markdowns presented in Section E.

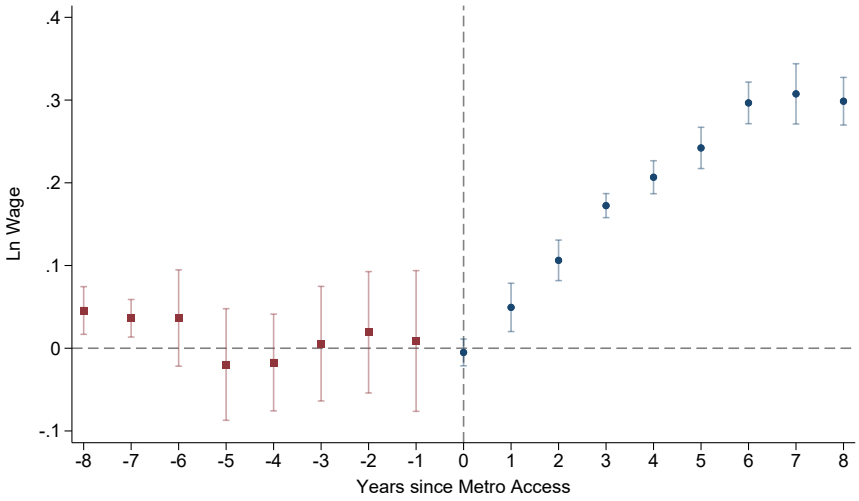
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gered difference in differences model of the form:

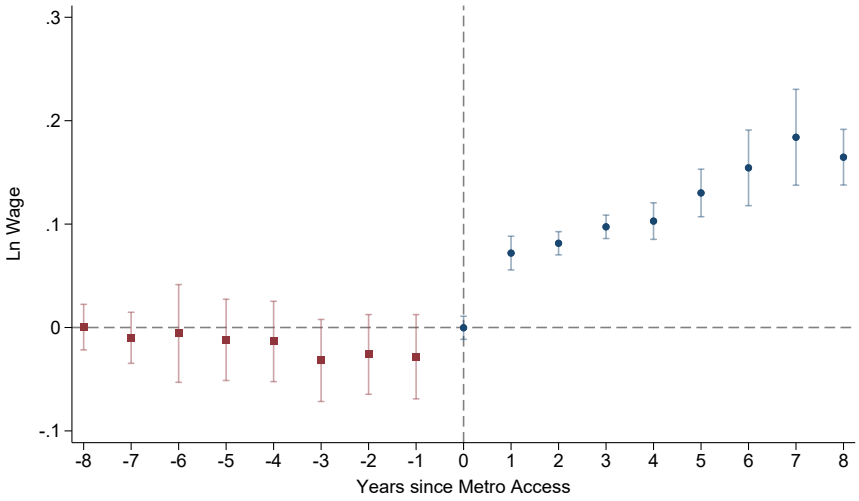
$$y_{it} = \alpha + \beta_1 \times \text{Post}_{m(i)t} \times I_m + \beta_2 \times \text{Post}_{m(i)t} + \beta_3 \times I_m + \gamma X_{it} + \theta_t + \theta_m + \varepsilon_{it}$$

where y_{im} is an indicator that worker i travel outside their residence (origin) location at time t, $\text{Post}_{m(i)t}$ indicates whether municipality m was already exposed to the expansion at time t, and 0 if not yet. I_m measures treatment intensity as the percentage reduction in travel time, X_i are worker controls, θ_m and θ_m are individual and time fix effects. Estimates use the 2006 and 2012 EOD waves, so treatment refers to the earlier expansions in 2010 and 2011. For travel time we use as approximation the observed average time to the city center.

Figure 5: Metro Network Expansion



(a) Movers Across Labor Markets



(b) Stayers in the Same Labor Market

Notes: Each panel displays results from the dynamic event-study specification, with the logarithm of wage as the dependent variable and time to the introduction of the metro in the municipality as the explanatory variable of interest. Panel (a) consist on a the subsample of workers that moved across labor markets whereas Panel (b) consists on workers that did not change their labor market. Standard errors are clustered at the municipality level.

C. Housing Market

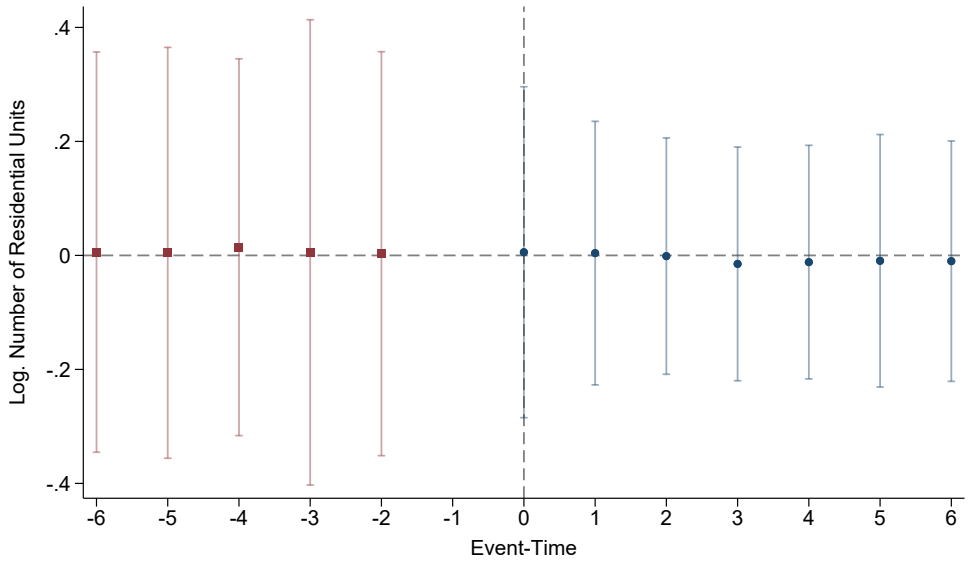
Do workers relocate to different municipalities of residence? A potential outcome of better connectivity between cheaper peripheral areas and high wage locations is that residents of well-connected, expensive, municipalities decide to move to cheaper municipalities that have gained public transport links.

To assess whether this margin is important, we evaluate the effect of new metro access on the number of residential property transactions using the staggered difference-in-differences approach. The results suggest a small and non significant effect. That is, new metro access in a municipality does not seem to be associated with a higher number of residential property transactions.

This may be the result of several factors. First, housing supply might not be elastic enough to prevent sharp price increases given new demand. Second, our data does not allow to identify residential moves within municipalities. It is a possibility that workers move within newly treated municipalities from areas far from the metro stations towards areas close to them. Third, frictions in the housing market, such as access to credit or transaction costs, likely do not allow people to move as freely as they would want. Finally, our estimation strategy compares municipalities treated earlier with those treated later. As such, it is possible that residents of our control municipalities expected to eventually have access to the metro and, given the long-term nature of housing decisions as well as the aforementioned frictions, decided to wait rather than move, despite the short to medium term costs associated with that decision.

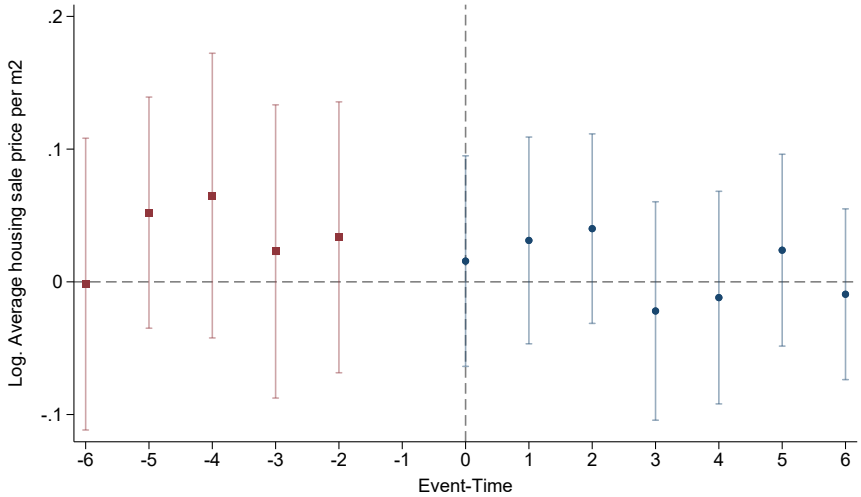
Looking at the effect on house prices, we find an increase of around 5 percent in the years following the opening of the new metro lines, although the result is not statistically significant. This is at odds with previous findings in Gupta et al. (2022) and López-Morales et al. (2023) for example, who study the effects of the extension of metro lines in New York and Santiago respectively and find capitalization on real estate sale prices. A potential explanation for those differences is that those studies focus on geographical areas within small radii of newly opened stations.

Figure 6: Number of residential properties transactions and the metro network expansion



NOTES: Results of the dynamic event-study specification using log of the number of residential properties and time to the metro introduction in the municipality. Clustered SE at the municipality level.

Figure 7: Price of the Residential Properties and the metro network expansion

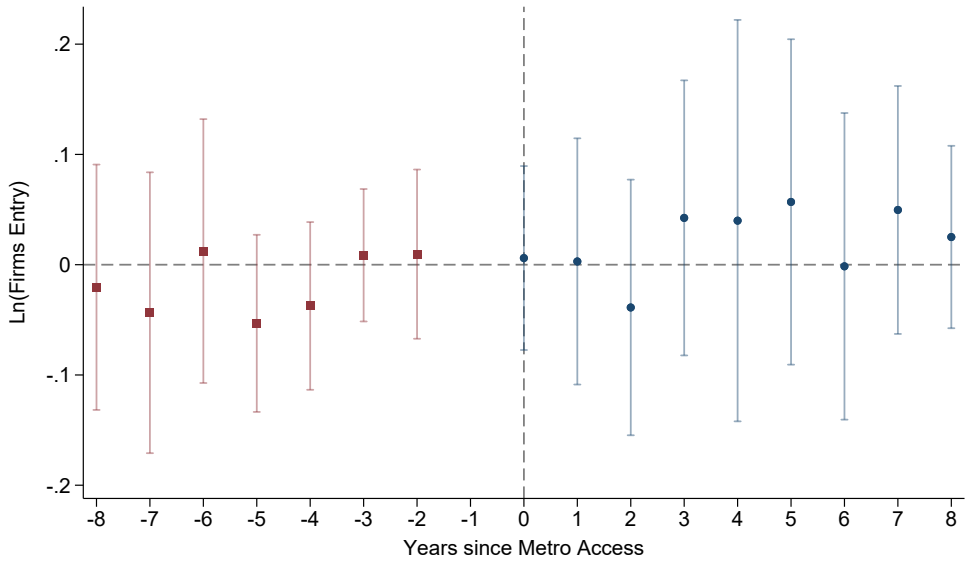


NOTES: Results of the dynamic event-study specification using log of the price of residential properties and time to the metro introduction in the municipality. Clustered SE at the municipality level.

D. Firms

What about firms? In principle, firms could also decide to move to areas with greater access to both workers and consumers. Similarly, firms might decide to move away from expensive real estate to cheaper areas that have become reachable after the expansion of the metro. Finally, some firms might move away from newly connected areas to areas that are still not well connected to continue exercising market power over workers. To evaluate whether firms reacted to the metro expansion, we study firm entry and exit, and firm relocation conditional on survival. We find no evidence that new firms enter in municipalities that have gained metro access (see Figure 8).

Figure 8: Firm entry and the metro network expansion

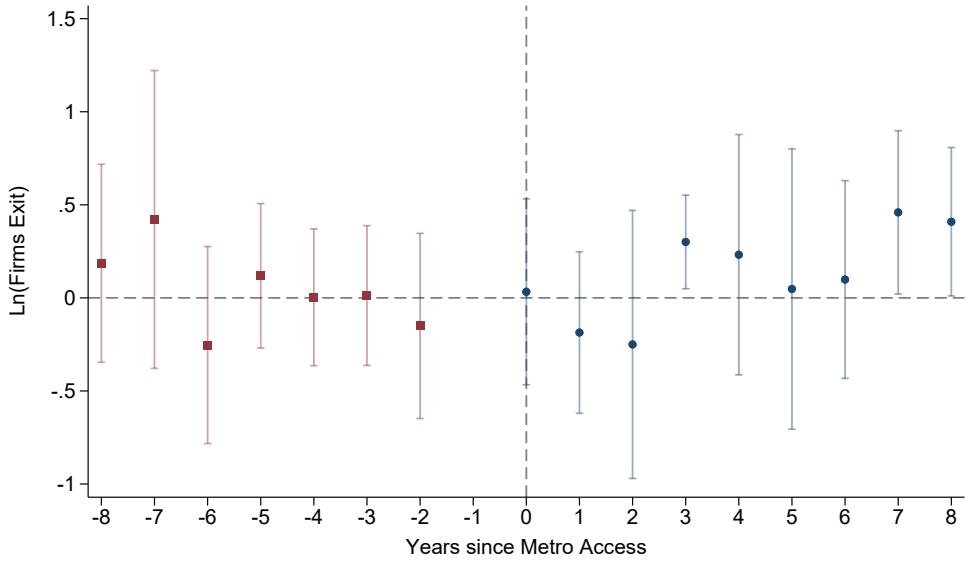


NOTES: Results of the dynamic event-study specification using log of the number of new firms and time to the metro introduction in the municipality. Clustered SE at the municipality level.

Similarly, we find no effect of new metro access on firm exit (see Figure 9). This is despite the fact, documented previously, that wages increase even for the workers that do not transition out of their local labor market.

Finally, we find no evidence of firm relocation conditional on survival. That is,

Figure 9: Firm closure and the metro network expansion



NOTES: Results of the dynamic event-study specification using log of the number of new firms and time to the metro introduction in the municipality. Clustered SE at the municipality level.

firms that survive are not more likely to relocate to other municipalities after the introduction of the metro (see Figure 10).

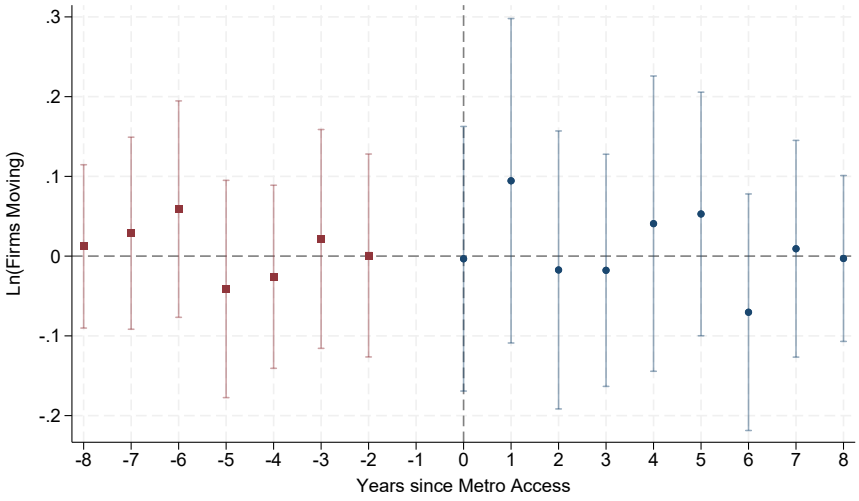
E. Labor Market Power

As discussed in Section E, we use markdowns, defined as the wedge between the marginal revenue product of labor and the wage, as our summary measure of employer market power.[10]

Empirical strategy (what changes and why). Our identification continues to leverage quasi-random variation in commuting times generated by the staggered roll-out of the metro network. The only change relative to the main wage specifications is practical: because our markdown measure requires estimating separation elasticities over multi-period windows, we cannot construct a

[10]See Manning (2021) for a synthesis of recent approaches to firm-specific wage setting and markdowns, and Sokolova and Sorensen (2021) for a meta-analysis of firm-specific labor supply elasticities that underpins markdown inference.

Figure 10: Firm relocation and the metro network expansion



NOTES: Results of the dynamic event-study specification using log of the number of firms relocating to the municipality and time to the metro introduction in the municipality. Clustered SE at the municipality level.

high-frequency event study by relative year. We therefore implement a two-period (pre vs. post) difference-in-differences with staggered timing at the labor market level m:

$$\mu_{mt} = \alpha_m + \delta_t + \beta Post_{mk(\text{treat}_m,t)} + X_{xmt}\theta + \varepsilon_{mt}$$

Where μ_{mt} is the markdown in municipality m and period t. Our baseline local labor markets are defined using job-to-job transitions in local labor markets defined by municipality of origin, sector and skill level. Post_{mt} indicates the post-opening period for the cohort in which m is first exposed. Identification relies on the same assumption as before: conditional on ultimately being treated, the timing of exposure is as-good-as-random with respect to markdown trends. This change in design is solely to accommodate the windowed construction of μ_{mt}; it does not alter the underlying identification logic.[11]

[11] The design choice follows the practical constraints posed by computing markdowns from separation hazards over multi-period windows.

Findings. In treated municipalities we estimate a decline in markdowns of about 6 percentage points, falling from roughly 29% to 23%. This is consistent with the intuition that faster commutes expand workers' choice sets, increase the value of their outside option, raise their labor supply elasticity, and compress markdowns. This fall in markdown explains around half of the wage increase in the local municipalities treated discussed earlier.

The markdown decline is larger in ex-ante smaller labor markets. Operationally, we proxy market size by number of firms and number of workers in the market. Interacting the size of the market with the treatment measure, we observe steeper markdown reductions where outside options were initially thin. This result is aligned with our discussion: introducing isolated locations to the metro network expands the opportunity set and increases the labor supply elasticity of their residents. In contrast, locations with ex-ante thick labor markets see smaller effects, as their residents already enjoyed a wide spectrum of choice before the new metro access.

The markdown compression is related to the wage gains we observe for incumbents who remain in their local market: more credible alternatives within commuting reach, firms must cede some of the wedge to retain workers. Our evidence showing no increase in firm exit further suggests that the reduction of employer market power is absorbed by firms, potentially through lower profit margins. While we lack spatially granular profit data to test profit pass-through directly, the absence of net entry responses is at least suggestive that firms had budgetary space to accommodate higher pay without immediate disinvestment.

F. Summary

In summary, our results from the staggered difference-in-differences specification show that new metro access leads to higher cross-market mobility for residents in treated municipalities and higher wages for both workers that transition to different local labor markets and for those that stay in their previous market. Similarly, a static difference-in-differences design allows us to show that previously small labor markets that are treated with new metro access see

Table 1: Markdowns and the Metro Expansion

	(1) Labor Market Markdown
After Metro [=1] x Small Labor Market [=1]	-0.108**
	(0.0426)
After Metro [=1] x Large Labor Market [=1]	-0.0274
	(0.0404)
Labor Market FE	Yes
Time FE	Yes
N	845

Note: Standard errors in parentheses. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$. The table reports the results for β from equation (1). The specification includes both fixed effect by Labor Market and Time.

a significant reduction of the average wage markdown.

Conversely, new metro lines do not appear to lead to significant changes in housing patterns nor prices. We find modest and statistically insignificant increases in both the number of residential units and the average house price per square meter. Finally, new metro access does not appear to have any effect on firm entry, exit, or relocation.

Jointly, these findings suggest that increased connectivity in Santiago led to significant changes in labor allocation across locations due to a greater number of commutes across municipalities, rather than due to firm changes or changes in places of residence.

VI. A Quantitative Spatial Model with Firm Market Power in Labor Markets

We build a quantitative spatial model of a city with imperfect competition in segmented labor markets. The model links commuting costs to firms' wage-setting power and connects two strands of research: monopsony and spatial urban models.

The economy consists of a city with a discrete set of locations, which differ in their housing supply, residential amenities, and their time to commute to other

locations. Workers decide where to live, where to work, and how to commute. Firms post wages to maximize profits subject to upward-sloping labor supply curves. The environment follows the urban structure used to study large transportation infrastructure changes (see, for instance, Tsivanidis, 2023; Greaney et al., 2025), with multiple locations that serve both as residence and work places, commuting, and multiple commuting modes, while introducing strategic wage posting and imperfect competition in the spirit of Card et al. (2018) and Armangué-Jubert et al. (2025). The equilibrium is characterized by optimal choices of workers and firms, and by market clearing in labor and housing. In what follows, we describe the environment, the worker and firm problems, the housing market, and the equilibrium conditions.

A. Environment

The city is divided into $m \in \mathcal{M}$ locations (or municipalities). Each municipality has an exogenous initial housing stock and residential amenities. There is an exogenous and discrete set of firms $\mathcal{J}$ that differ only in their productivity type $x \in \mathcal{X} = \{\text{low}, \text{high}\}$. Firms are exogenously located in one of the $\mathcal{M}$ municipalities.

There is a continuum of mass one of workers that differ in their skills $x \in \mathcal{X}$, and choose residence municipality m, employer $j(n)$ located in municipality n, and commute mode $k \in \mathcal{K} = \{\text{car}, \text{public transport}\}$. Workers value wages and local amenities, and dislike housing rents and commuting costs that depend on travel time and mode. Finally, workers are assumed to have idiosyncratic preferences over residential locations, commuting modes, and employers.

The timing of the model is as follows: 1) workers observe the distribution of firms, commuting time matrices and residential amenities, and decide where to reside, 2) firms post wages with knowledge of the labor supply function and interiorizing the effect of their decision on aggregate variables, 3) workers choose which firm to work for after observing their idiosyncratic taste preferences, 4) workers choose how to commute to work, and 5) production and consumption take place.

B. Workers

A worker i of type x chooses a residence municipality m, an employer j located in n, and the mode of transport k to use to commute to work. Workers derive utility from consumption of a freely traded good and residential amenities A_m. To live in m they have to pay housing rent R_m. Workers of type x that choose to commute from m to n using mode k incur a cost $d_{mnxk}(\Theta_{mnk})$, where Θ is the exogenous tensor of commuting times by mode of transport. The indirect utility of worker i that has chosen m, j, k is given by

$$U_{imjk} = w_{jx} + (A_m - R_m) - \gamma d_{mnxk}(\Theta_{mnk}),$$

where w_{jx} is the wage paid to the worker i of type x in firm j. Workers first choose where to live, then where to work, and finally which transport mode to use. We solve their problem by backward induction.

Commuting mode decision

After workers have chosen where to live and which firm to work for, they choose how to commute from their municipality of residence to the municipality of their employer. Workers can choose one of two commuting modes, they can either use a car (a) or public transport ($\mathbb{p}$). If they choose to use a car, they must pay a fixed cost of f_a. Workers of different types have different tastes over car ownership δ_x. Thus, if workers have a car, their utility would incorporate a term $f_a - \delta_x$, where a higher δ_x lowers the perceived car cost. We normalize the taste of low-skill workers to $\delta_{ls} = 0$, and set the taste of high-skill workers equal to $\delta_{hs} = \delta$. To make their decision, workers observe Θ_{mnk}, the commute time from m to n by k. Individuals have idiosyncratic preferences over modes u_{ik}, which are assumed to follow a Gumbel distribution with scale parameter σ. Therefore, the realized commute disutility for worker i after the choice is made is given by

$$d_{mnxk}(\Theta_{mnk}) = s\Theta_{mnk} + \mathbb{1}[k = a](f_a - \delta_x) + u_{ik}.$$

It follows that the commuter's problem conditional on their previous choices m and $j(n)$ is

$$\min_{k \in \mathcal{K}} d_{mnkx}(\Theta_{mnk}).$$

Our distributional assumption on u_{ik} implies that the probability that a worker i, of type x, that is resident in m and works in n, chooses to commute in public transport is given by:

$$p_{\mathbb{p}|mnx} = \frac{\exp\left(\frac{-s\Theta_{mn\mathbb{p}}}{\sigma}\right)}{\exp\left(\frac{-s\Theta_{mn\mathbb{p}}}{\sigma}\right) + \exp\left(\frac{-[s\Theta_{mna}+(f_a-\delta_x)]}{\sigma}\right)} \tag{5}$$

While the probability of using a car for the same worker is the inverse of that probability $p_{a|mnx} = 1 - p_{\mathbb{p}|mnx}$.

Lets define $\tilde{d}_{mnxk}$ as the deterministic part of the disutility of mode k. Given the distributional assumption on u_{ik}, the expected value of the commuting decision prior to drawing the idiosyncratic preference shocks is equal to

$$d_{mnx} = -\sigma \log\left[\exp(-\frac{\tilde{d}_{mnxa}}{\sigma}) + \exp(-\frac{\tilde{d}_{mn\mathbb{p}}}{\sigma})\right], \tag{6}$$

and the utility of choosing residence municipality m and employer j, located in n, prior to making the commuting mode decision is

$$U_{ixmj} = w_{jx} + (A_m - R_m) - \gamma d_{mnx}$$

Employment decision

After choosing where to live, workers decide what firm j to work for. Given that each firm is exogenously located in a given municipality, this choice also implicitly entails choosing their commuting route. Workers value wages and dislike long and costly commutes. Moreover, workers have idiosyncratic preferences over firms u_{ij}, which are assumed to be distributed Gumbel with scale parameter ψ. The utility of choosing firm j after having chosen to live in m is then given by

$$U_{ixmj} = w_{jx} - (R_m - A_m) - \gamma d_{mnx} + u_{ij}.$$

It follows that the employment decision is

$$\max_{j \in \mathcal{J}} \left\{ w_{jx} - \gamma d_{mnx} + u_{ij} \right\},$$

where d_{mnx} is the expected value of the disutility of the commute from m to n after the commute mode has been chosen, as defined in equation (6). Our distributional assumption on u_{ij} implies that the probability that worker i, of type x, and resident in m, chooses to work for firm j, located in n is given by

$$p^{\ell}_{j|mx}(w_{jx}, \vec{w}_x) = \frac{\exp\left((w_{j(n)x} - \gamma d_{mnx}(\Theta_{mn}))/\psi \right)}{\sum_{l=1}^{J} \exp\left((w_{l(n')x} - \gamma d_{mn'x}(\Theta_{mn'}))/\psi) \right)} \tag{7}$$

Where $\vec{w}_x$ is the vector of wages posted by all other firms. It follows that the probability of working for firm j depends on its relative posted wage and the relative expected cost of commuting to its location, which depends on the exogenous time distance between the worker's location and the firm's.

Following Tsivanidis (2023), we can rewrite the denominator of probability defined in equation (7) as Φ_{mx}, which is a measure of Residential Commuter Market Access (RCMA).

$$\Phi_{mx} = \sum_{l=1}^{J} \exp\left(\frac{w_{lx}}{\psi} \right) \times \exp\left(\frac{-\gamma d_{mn'x}(\Theta_{mn'})}{\psi} \right).$$

The RCMA measure (Φ_{mx}) captures residents' access to well-paid jobs from their location of residence m. Individuals will be more likely to commute to firms with a higher wage net of the expected value of the commuting costs, relative to other locations. The sensitivity of the decisions is governed by the dispersion of workers tastes. A higher ψ will make decisions less sensitive to changes in wages.

As before, given our distributional assumption on the idiosyncratic taste shocks over firms u_{ij}, the expected value of the employment decision before the shocks

are realized can be written as

$$V_{xm} = \psi \log \left(\sum_j \exp \left(\frac{w_{jx} - \gamma d_{mnx}(\Theta_{mn})}{\psi} \right) \right) \tag{8}$$

Which can be also written as a function of the RCMA $V_{xm} = \psi \log(\Phi_{mx})$.

Residential Choice

In the first stage of the problem, workers decide where to live. Workers choose a municipality $m \in \mathcal{M}$, given the vector of residential amenities associated to each location, the rent price, and the tensor of commuting time by mode. Workers have idiosyncratic preferences over locations, assumed to be distributed Gumbel with scale parameter λ.

The indirect utility to an agent of type x of choosing to live in m can be written as

$$U^H_{xm} = A_m - R_m + V_{xm} + u^H_{im},$$

where A_m and R_m are the residential amenities and rent prices in m, respectively, and V_{xm} is the expected value of working, conditional on living in m, which includes both the choice over firms and commuting mode. The residential problem of the worker is then characterized by

$$\max_{m \in \mathcal{M}} \left\{ A_m - R_m + V_{xm} + u^H_{im} \right\}.$$

Given the distributional assumption on u^H_{im}, the probability that a worker of type x chooses to live in municipality m is given by

$$p^h_{m|x} = \frac{\exp\left((A_m - R_m + V_{xm})/\lambda\right)}{\sum_{m'} \exp\left((A_{m'} - R_{m'} + V_{xm'})/\lambda\right)} \tag{9}$$

It follows that the total housing demand by workers of type x in municipality m will be $D^h_{mx} = \mu_x \times p^h_{m|x}$, and the total housing demand in m will be:

$$D_m^h = \sum_x D_{mx}^h = \sum_x \left[\mu_x \times \frac{\exp((A_m - R_m + V_{xm})/\lambda)}{\sum_{m'} \exp((A_{m'} - R_{m'} + V_{xm'})/\lambda)} \right] \tag{10}$$

Workers value locations with relatively higher amenities A_m, lower rents R_m and relatively higher expected values of working, conditional on living in there. Higher dispersion in λ makes workers' decisions less reactive to changes in those fundamentals.

C. Aggregation

Location Choice

Lets define the location-level probability as the sum of firm probabilities within that location:

$$p_{n|m} = \sum_{j \in n} p_{j|m}$$

From equation 7, we can express the probability of working in n given that worker lives in m:

$$p_{n|m} = \frac{S_{nx} \exp(-\frac{\gamma}{\psi} d_{mn})}{\sum_{\ell \in \mathcal{N}} S_{\ell x} \exp(-\frac{\gamma}{\psi} d_{m\ell})} \tag{11}$$

Where $S_{nx} = \sum_{j \in n} \exp(\frac{w_{jx}}{\psi})$. In general, one can understand S_{nx} as measure of job opportunities in n and γ/ψ as the semi-elasticity of utility with respect to commuting costs. A smaller ψ or larger γ both increase sensitivity to commuting frictions.

A gravity equation for flows

From equation 10, D_m^h is the number of workers living in m. The commuting flows from m to n are defined by:

$$L_{mn} = D_m^h \times p_{n|m}$$

If we plug in equation 11 and take logs in the above expression, we can express the log of flows from m to n as:

$$\ln L_{mn} = \ln D_m^h + \ln S_n - \frac{\gamma}{\psi} d_{mn} - \ln \sum_{\ell \in \mathcal{N}} S_\ell \exp(-\frac{\gamma}{\psi} d_{m\ell})$$

Lets define $\Lambda_m = \ln \sum_{\ell \in \mathcal{N}} S_\ell \exp(-\gamma \frac{d_{m\ell}}{\psi})$. We can group the terms into elements that are origin-specific $\alpha_m = \ln D_m^h + \Lambda_m$, those that are destination-specific $\omega_n = \ln S_n$, and d_{mn} that is origin-destination specific. Then, we can define the following structural gravity equation:

$$\ln L_{mn} = \alpha_m + \omega_n - \frac{\gamma}{\psi} d_{mn} \tag{12}$$

In this equation α_m absorbs the origin mass L_m and the origin-specific normalization Λ_m, that represent the log-sum across all destinations for origin m. ω_n absorbs S_n that captures the quality of firms in n. Lastly, d_{mn} could be understood as a bilateral friction term between origin m and destination n.[12]

Labor Supply to the Firm

The supply of type-x workers to firm j, located in n is the sum of all workers that choose to work for firm j conditional on their place of residence $L_{jx} = \sum_m D_{m|x}^h \times p_{j|xm}^\ell$. This implies that:

$$L_{jx} = \exp\left(\frac{w_{jx}}{\psi}\right) \Phi_{mnx}^J(\Theta_{mnk}, \vec{w}_{jx}) \ , \tag{13}$$

Where, following Tsivanidis (2023), we can define Φ_{mnx}^J as a measure for Firm Commuter Market Access (FCMA), such that $\Phi_{mnx}^J = \sum_m D_{mx}^h \frac{\exp(-d_{mnx}(\Theta_{mn})/\psi)}{\Phi_{mx}}$.

Labor supply is then log-linear and depends on four forces. First, more workers commute to firms paying higher wages. Second, workers' labor supply is less elastic if the idiosyncratic taste dispersion parameter ψ is high. Third, con-

[12] A special case of equation 12 is when the wages are the same within location. In that case, $S_n = J_n \exp(w_n/\psi)$, which implies $\omega_n = \ln J_n + \frac{w_n}{\psi}$

ditional on wages, firms attract more workers if they are better connected to them through the commuting network. Fourth, workers's labor supply will be less elastic if, and their housing decision will depend less on amenities and rents, if the idiosyncratic taste over locations of residents parameter λ is higher. Firm labor market power arises from two sources: 1) idiosyncratic firm taste makes firms be differentiated and endows them with wage-setting power, and 2) the commuting network makes some workers "captive" in certain locations, endowing firms there with wage-setting power.

Wage Elasticity of the Labor Supply to the Firm

The elasticity of the type x worker labor supply to the firm is $\varepsilon_{jx} = \frac{\partial L_{jx}}{\partial w_{jx}} \frac{w_{jx}}{L_{jx}}$. Intuitively, the derivative of the labor supply can be written as:

$$\frac{\partial L_{jx}}{\partial w_{jx}} = \sum_m D_{mx} \frac{\partial p^{\ell}_{j|xm}}{\partial w_{jx}} + \sum_m \frac{\partial D_{mx}}{\partial w_{jx}} p^{\ell}_{j|xm}$$

The overall change of labor supply to the firm can be descomposed in two components. The first term reflects changes of the probability of working in firm j within the municipality while the second one represents resorting of workers across residences.

From equation 13, this can be also expressed as:

$$\frac{\partial L_{jx}}{\partial w_{jx}} = \frac{1}{\psi} L_{jx} + \frac{L_{jx}}{\Phi^J_{mnx}} \frac{\partial \Phi^J_{mnx}}{\partial w_{jx}}$$

Which similarly, implies that the change in labor supply to the firm will depend on the workers idiosyncratic preferences and the RCMA. A direct implication of this expression is that we can express the labor supply elasticity to the firm with the following expression:

$$\varepsilon_{jx} = \frac{w_{jx}}{\psi} + \frac{w_{jx}}{\Phi^J_{mnx}} \frac{\partial \Phi^J_{mnx}}{\partial w_{jx}} \tag{14}$$

Where the second term is non-zero because wages change V_{xm}, hence $p^h_{m|x}$, hence D^h_{mx} and hence Φ^J_{mnx}. This decomposition shows that transit or congestion that shifts d_{mnx} operates through both Φ terms, and thus changes markdowns even holding productivities fixed.

D. Firms

Production Function

There are $j \in \{1, ..., J\}$ firms that produce a single consumption good that is traded in a perfectly competitive market, with a price normalized to one. Firms have different productivity types $z \in \mathcal{X}$ and produce using a CES technology over different labor types x.

$$Y_j = A_{z(j)m} \left(\sum_x \beta_{z(j)x} L^{\rho}_{jx} \right)^{\frac{1}{\rho}}$$

Where the elasticity of substitution between workers types is $\sigma = \frac{1}{1-\rho}$, $\beta_{z(x)x}$ is the labor share, and A_{zm} is the productivity of type z firm located in m, which firms take as given. Different types of firms differ in the intensity in which they use different types of workers x.

For computational simplicity, we will assume two types of workers by skill $x = \{\text{low}, \text{high}\}$ and two type of firms by productivity $z \in \{\text{low}, \text{high}\}$.

Firms' Problem

Firms will maximize their profits subject to the upward-sloping labor supply that they face.

$$\max_{w_{xj}} \pi_j(w_j, \bar{w}_j) = \max_{w_{xj}} \left[\sum_x (\text{MPL}_{jx} - w_{jx})\, L_{jx}(w_{jx}, \bar{w}_{j'x}) \right]$$

$$\text{s.t. } L_{jx}(w_{jx}, \bar{w}_{j'x}) = \exp\left(\frac{w_{jx}}{\psi}\right) \Phi^J_{mn}(\bar{w}_{j'x})$$

Where $\bar{w}_{j'x} = \{w_1, ..., w_J\}$ such that $j' \neq j$.

Then, under standard results, the optimality implies that the labor supply will

be given by:

$$L_{jx} = \left(\frac{\partial Y_j}{\partial L_{jx}} - w_{jx} \right) \frac{\partial L_{jx}}{\partial w_{jx}},$$

where $\frac{\partial Y_j}{\partial L_{jx}}$ is the marginal productivity of firm j and $\frac{\partial L_{jx}}{\partial w_{jx}}$ is the change of labor supply given a change in the wage of firm j. Lets define the firm markdown as $\mu_x = \frac{MPL_{jx} - w_{jx}}{MPL_{jx}}$, then the relationship between markdown and elasticity is defined by:

$$\mu_{jx} = \frac{1}{1 + \varepsilon_{jx}}.$$

The markdown should be read as the percentage gap between a workers' wage and their marginal product. A markdown of 0.2 means that the firm is paying a wage equal to the 80 percent of the worker's marginal product. If workers' labor supply is perfectly elastic, they immediately respond to wage changes and firms have no market power and wages equal the marginal product. Conversely, if workers' labor supply is perfectly inelastic, they do not react to wage changes and firms have complete market power and wages are set far below marginal product.

E. Housing Market

Housing in the city is provided in a competitive market. In each municipality m there is an initial stock of housing H_{0m} and some exogenous amenities given by A_m. The residential demand in m is defined by equation 10. The housing supply is defined by:

$$R_m = \kappa_m \left[\frac{H_m}{H_{0m}} \right]^{1/\varepsilon}$$

where $\varepsilon > 0$ is the housing supply elasticity and $\kappa_m > 0$ is a municipality-specific shifter (capturing land and regulatory fundamentals). Note that when $H_m = H_{0m}$, $R_m = \kappa_m$.[13] An alternative specification allows the housing supply

[13] One microfoundation is given by competitive, price-taking developers with convex cost $C_m^{\text{dev}}(H_m) = \kappa_m \frac{\epsilon}{1+\epsilon} H_{0m}^{-1/\varepsilon} H^{1+1/\varepsilon}$. The first-order condition $R_m = \frac{\partial C_m^{\text{dev}}(H_m)}{\partial H_m}$ then yields our housing supply. In our analysis κ_m is treated as a reduced-form shifter, so the microfoundation

elasticity to vary across space. Let $\varepsilon_m > 0$ denote the elasticity in municipality m. Then the inverse supply is $R_m = \kappa_m \left(\frac{H_m}{H_{0m}}\right)^{1/\varepsilon_m}$, so developers' responses to a given demand shift differ by location. The limiting case $\varepsilon_m \to 0$ corresponds to perfectly inelastic (short-run) supply, in which the housing stock is fixed at H_{0m} and adjustment occurs through rents; this appears as a short-run benchmark in, for example, Tsivanidis (2023). Our baseline follows Fuenzalida and Sepúlveda (2024), who impose a common elasticity ε for the city of Santiago.

The housing market equilibrium will be given by $H_m = D_m^h$, where the residential rental prices will adjust to clear the market.

F. Equilibrium

Given the housing market parameters $H_0, \kappa_m, A_m, \varepsilon$, the commuting decision parameters, $\Theta_{mnk}, s, \varphi, f_a, \delta_x$, the gumbel parameters σ, ψ, λ and the CES parameters A_z, β_{zx}, ρ, the solution is a vector of labor supply decisions $\bar{\mathrm{p}}_J^{\ell*} = [p_1^{\ell*}, ..., p_J^{\ell*}]$, a vector of wages $\bar{\mathrm{w}}_{XJ}^* = [w_{x1}^*, ..., w_{xJ}^*]$, a vector of housing decisions $\bar{\mathrm{p}}_{hM}^* = [p_1^*, ..., p_M^*]$, a vector of housing prices $\bar{\mathrm{R}}_M^* = [R_1^*, ..., R_M^*]$, and a vector of transport mode decisions $\bar{\mathrm{p}}_k = \vec{p}_{xmnk}$ such that: 1) given rents and parameters, $\bar{\mathrm{p}}_{hM}^*$ solves the residence choice problem, 2) given wages and parameters $\bar{\mathrm{p}}_J^{\ell*}$ solves the problem of firm choice, 3) given wages and parameters, $\bar{\mathrm{p}}_k$ solves the commute mode choice, and 4) the labor market clears and housing market clear.

VII. Model Results and Counterfactuals

In order to evaluate the effect of the metro in general equilibrium and to run alternative counterfactuals, we estimate the quantitative model in Section VI. Some parameters are normalized or taken from previous literature, others are calibrated using structural equations from the without solving the model, and the remaining parameters are internally calibrated. The estimated model allows us to study how commuting frictions shape firms' wage-setting power in space.

is not required.

A. Parameter Calibration

We split parameters into two groups: those calibrated without solving the model, either using structural equations from the model or from values that come from previous literature, and those internally calibrated by matching equilibrium moments.

A.1. Parameters calibrated without solving the model

Commuting costs and mode decision $\{s, f_a, \delta, \sigma, \gamma\}$**.** We normalize $\sigma = 1$, so σ is absorbed into $\{s, f_a, \delta_x\}$. To estimate s, f_a, δ_x we exploit cross-sectional variation in mode times. We estimate a logit for the mode choice on trip-level data with choice-varying time-of-day and demographic controls. The time semi-elasticity s is identified from within–OD variation in relative travel times across modes.

Table 3 shows the results from estimating the commuting mode equations. We estimate the equation with and without controls[14], and the results are similar across both of them, with the private mode constant being higher in the specification that includes controls.

$$s = 0.0168, \qquad \delta_{hs} = 0.745, \qquad f_a = 0.702$$

Our results are close to those found in the literature. Tsivanidis (2023), for instance, in a similar setting of mode choice, finds a parameter for time of 0.012 and a car constant of $f_a = 0.853$. They do not estimate a comparable δ_{hs} coefficient.

The commute elasticity can be estimated from the equation 12. Table 4 shows the results of estimating the gravity equation by Poisson pseudo–maximum likelihood (PPML) with origin (α_m) and destination (ω_n) fixed effects. The reported coefficient is that on travel time in minutes.

Given that the coefficient on d_{mn} is $\gamma_d = s\gamma/\psi$, we can recover for a given value

[14] We include dummies for age range and gender, which is equivalent to allowing preferences for each mode to vary by these characteristics. We also controls for departure time ranges.

of ψ and the estimated parameter for s:

$$\widehat{\gamma} = \psi \cdot \widehat{\gamma}_d / \hat{s}.$$

To address potential endogeneity of realized travel times, we instrument the observed Θ_{mnk} with the minimum feasible route time between m and n by mode (free–flow/shortest–path time). This instrument varies with network topology but is orthogonal to individual routing choices. When estimating with d_{mn} on the right–hand side, we construct a fitted inclusive cost $\widehat{d}_{mn}$ by plugging the instrumented $\widehat{\Theta}_{mnk}$ into the log–sum expression. Standard errors are clustered by origin–destination pair. It is encouraging that our results are close to those of Tsivanidis (2023) and Monte et al. (2018).

Housing market parameters $\{\varepsilon, \kappa, H_0\}$. We set the housing supply elasticity to $\varepsilon = 0.5$ following evidence for Santiago from Fuenzalida and Sepúlveda (2024).[15] We recover κ_m from pre-expansion equilibrium: given H_{0m} and pre-expansion residential shares, we back out the inverse supply shifter so that $H_m = H_{0m}$ implies $R_m = \kappa_m$.[16]

Production function parameters. Following Card (2009) and Tsivanidis (2023), we set the elasticity of substitution between skill groups to $\sigma = 1/0.7 \approx 1.43$ for the baseline calibration. We perform robustness exercises where we set alternative values for the elasticity. We then recover the CES share parameters β_{zx} using firm data on wage-bill shares by worker type $x \in \{\text{low}, \text{high}\}$, allowing the weights to differ by firm type. We normalize $\beta_{z,\text{low}} = 1$ for both firm types and back out $\beta_{z,\text{high}}$ from their first-order conditions. The estimated high-skill weights are $\beta_{\text{low productivity,high skill}} = 0.673$ $\beta_{\text{low productivity,high skill}} = 0.704$. Be-

[15] Fuenzalida and Sepúlveda (2024) estimate the short-term housing supply elasticity for the Metropolitan Region of Santiago using quasi-experimental variation from the introduction of Chile's Subsidio Habitacional (homeownership voucher) program in 2011. The authors construct a shift–share instrument that interacts the pre-policy share of properties eligible for each voucher type with the annual number of vouchers issued, generating exogenous variation in local housing demand across neighborhoods.

[16] Alternatively, we can use administrative counts of the housing stock and an assumed occupancy per unit to construct $\tilde{\kappa}_m$; the resulting distribution is close to the one implied by pre-expansion rents and leaves our counterfactuals essentially unchanged.

cause both $\beta_{z,\text{high}} < 1$, the implied CES weights place greater relative mass on low-skill labor in both firm types, with the tilt toward low-skill slightly stronger in low-productivity firms. The βs are distribution parameters of the CES aggregator (not mechanical wage-bill shares), so they adjust for observed wage gaps and the assumed σ. Our approach mirrors the calibration of skill-specific demand shifters from wage-bill data in Tsivanidis (2023), whose estimate of the shares are around 0.7 depending on the economic sector, with low productivity sectors having relatively lower shares.

A.2. Parameters estimated solving the full the model

Labor Market $\{\psi\}$. We estimate ψ internally via the Method of Simulated Moments (MSM). We target the pre-expansion average markdown, $\bar{\mu} = 0.23$, obtained from our reduced-form estimates. In our model, with $L_{jx} = \exp(w_{jx}/\psi)\Phi^{J}_{mnx}$, ψ controls the logit sensitivity of employment to firm-specific wages. Then, given production and commuting parameters, ψ pins the average firm-level labor-supply elasticity. Our calibrated value is $\psi = 0.19$.

CES Function $\{A_{zm}\}$. We calibrate firm-type-by-municipality productivity by matching pre-expansion wages across municipalities and worker and firm types, holding fixed the remaining CES production parameters.

Housing Market $\{\lambda\}$. We estimate λ by matching pre-expansion residential shares across municipalities using equations (9) and (10). Intuitively, lower λ raises the responsiveness of residence choices to $(A_m - R_m + V_{xm})$ and increases the strength of RCMA. Our calibrated value is $\lambda = 1.302$.

B. Model results, welfare and distributional analysis

B.1. General Results

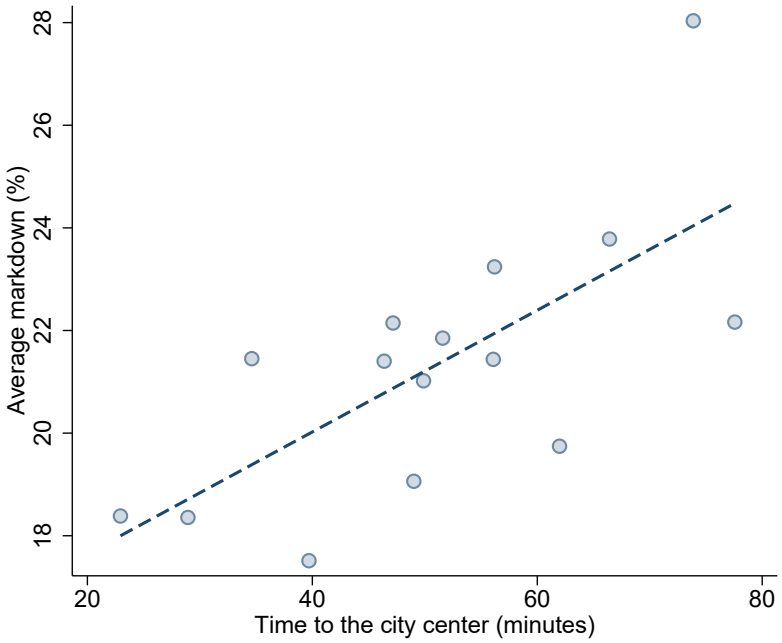
The model produces a positive relationship between markdowns and commuting times to the city center (Figure 11).[17] This pattern is not targeted in the

[17] Commuting time is measured as the average time to the city center. An alternative measure would be the average distance to all other municipalities. We prefer the former because it is not influenced by workers' actual choices and is defined for every location. The average

calibration. It emerges from equilibrium interactions among commuting costs, wages, amenities, and housing prices, which depend on the housing market equilibrium and on the parameters governing workers' preferences over residence and workplace choices.

While other studies have explored the connection between commuting and labor market power, our framework highlights that this relationship depends as well on the interaction with the housing market. Lower commuting costs affect residential sorting and rents, which modify workers' net utility and the elasticity of labor supply to firms. This feedback amplifies the effect of spatial frictions on market power.

Figure 11: Markdowns versus time to the city center



Notes: The figure shows, for each location, the model-implied average wage markdown and the average public-transit travel time to the city center, in minutes. Travel times come from pre-expansion data. The city center is defined as Santiago and Providencia. The calibration does not target location-specific markdowns, only the citywide average markdown pins down the scale parameter of the labor-supply decision.

distance to other municipalities eventually reflects endogenous commuting patterns, which are more an outcome than an exogenous reference.

We then simulate the effects of the metro expansion using the updated commuting-time matrix. The new matrix modifies public-transit and car travel times for every pair of municipalities, and we recompute equilibrium outcomes using the new costs.

The model predicts average wage gains of about 6 percent after the expansion. These gains are smaller than those observed empirically, which may reflect our parsimonious specification. The current version abstracts from firm–worker productivity matching, so workers do not draw match-specific productivity shocks as in models where matches follow a Fréchet distribution (Tsivanidis, 2023). It also assumes a CES production function with constant returns to scale, which prevents productivity from increasing with employment size. As a result, the simulated wage gains arise exclusively from a reduction in firms' market power, not from productivity improvements.

C. Welfare accounting

We report welfare at two levels. First, we measure welfare conditional on residence, which isolates the access margin holding the residence m fixed. Second, we measure welfare ex ante, which evaluates expected utility before the residential choice. This presentation separates gains that operate through improved access to jobs from gains that operate through re sorting and housing market feedbacks.

Welfare conditional on residence. For a worker of type x who resides in m, the expected value from the workplace and mode decisions is

$$V_{xm} \;=\; \psi \,\log\!\left(\sum_{j} \exp\!\left(\frac{w_{jx} - \gamma\, d_{mnx}(\Theta_{mn})}{\psi}\right)\right),$$

where w_{jx} is the wage paid by firm j to type x, n is the location of firm j, and $d_{mnx}(\Theta_{mn})$ is the expected commuting disutility that aggregates across modes with parameter σ. Given amenities A_m and rent R_m, welfare that holds residence fixed is

$$U^{\text{cond}}_{xm} \;=\; A_m \;-\; R_m \;+\; V_{xm}.$$

Reductions in travel times lower $d_{mnx}(\Theta_{mn})$ and raise V_{xm} because the set of accessible firms expands and outside options improve.

Ex ante welfare before the residential choice. Prior to choosing m, expected utility for type x is the residence inclusive value with dispersion λ:

$$\overline{U}_x^{\text{ex ante}} \;=\; \lambda \,\log\!\left(\sum_m \exp\!\left(\tfrac{A_m - R_m + V_{xm}}{\lambda}\right)\right).$$

This object aggregates direct access gains in V_{xm} and equilibrium adjustments through R_m and residential re sorting. As a baseline we also report a version that fixes the residence shares at their pre expansion values π^0_{xm}:

$$\ln \overline{U}_x^{\text{ex ante}}\big|_{\text{fixed } \pi^0} \;=\; \sum_m \pi^0_{xm}\, \ln\!\big(U^{\text{cond}}_{xm}\big).$$

Aggregation and distribution by skills. Citywide welfare for group x is obtained either with fixed residence shares π^0_{xm} or with the inclusive value across m. We report all objects by skill x and we present the decomposition of changes in U^{cond}_{xm} into the housing price term, the amenity term, the wage term, and the commuting term. We then aggregate to $\overline{U}_x^{\text{ex ante}}$ to compare total gains across skills in the spirit of the distributional analyses in urban transit models Tsivanidis (2023). For reference we also show the competitive benchmark and the contribution of markdown movements in the style of welfare accounting used in quantitative trade and spatial work.

D. Mechanisms

To isolate the link between commuting costs and wage-setting power, we conduct a local network counterfactual that proportionally shortens public transport travel times for a single municipality m while holding all other fundamentals fixed, including other municipalities m' travel times.[18] Formally, for a given reduction rate $\Delta \in \{0.1, 0.2, ..., 0.7\}$, we set:

[18] A reduction in private transport travel times enhance the effect of the public transport reductions.

$$\Theta'_{mnk} = (1 - \Delta)\Theta_{mnk}$$

for all destinations n and $k \in$ public transport, leaving $\Theta_{m'n't}$ unchanged for all other $(m', n') \neq (m, \cdot), (\cdot, m)$. Amenities (A_m), housing supply fundamentals $(H_{0m}, \kappa_m, \varepsilon)$, and production parameters are held at baseline values. Given the new travel-time tensor Θ', we re-solve for the general equilibrium of wages, commuting, and residential location as in Section VI, and compute firm-type markdowns $\mu_{jx}(\Delta) = \frac{\text{MPL}jx - wjx(\Delta)}{\text{MPL}_{jx}}$.

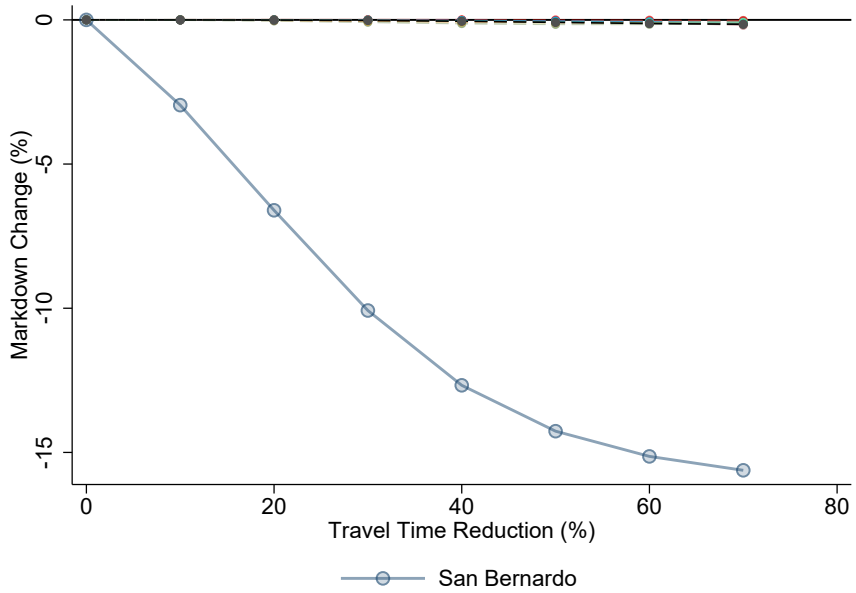
We implement this experiment for $m =$ San Bernardo. The exercise is also robust to using other peripheral municipalities, defined as those in the upper tercile of the pre-expansion travel-time distribution, yielding qualitatively similar patterns.

Figure 12 plots the change in markdowns (in percentage points) as a function of Δ. The treated municipality experiences a pronounced decline in markdowns: at $\Delta = 0.70$ the markdown falls by about 4 percentage points. By contrast, markdowns in other municipalities are largely unchanged, with small negative spillovers concentrated in municipalities geographically close to San Bernardo.

The counterfactual acts on the consumer market access (CMA) terms that shape worker flows in our model. For residents of m, shorter Θ_{mnk} raise Residential CMA (Φ_{mx}), while firms located in or near m enjoy higher Firm CMA (Φ^J_{mnx}). In equilibrium, the supply of type-x workers to firm j located in n is given by equation (13), so the firm's own-wage semi-elasticity (and hence its labor supply elasticity) is the sum of (i) the logit sensitivity $1/\psi$ and (ii) the re-sorting response through Φ^J_{mnx}.

Reducing Θ_{mnk} increases the mass of feasible outside options reachable from m, which makes the labor supply to any single firm more elastic. Because markdowns satisfy $\mu_{jx} = 1/(1 + \varepsilon_{jx})$, the rise in ε_{jx} translates into lower markdowns for firms serving workers in the treated market and, via spatial substitution, small markdown declines for nearby municipalities as competition for workers intensifies. This mechanism shows that commuting frictions are a first-order source of monopsony power in urban labor markets, and that relax-

Figure 12: Markdowns changes versus commuting costs to other firms changes



NOTES: Figure plots the change in the average wage markdown (μ) reduction by municipality under counterfactual, uniform reductions in commuting times to/from San Bernardo. The x-axis shows the percentage reduction in travel time (0–70%); the y-axis reports the change in μ in percentage points relative to the baseline equilibrium (negative values = smaller markdowns, i.e., wages closer to marginal product). The solid line is the "treated" municipality; dashed lines are all other municipalities. For each counterfactual we scale public-transport times in the San Bernardo-other pairs by the same factor, holding all other OD times and location fundamentals (amenities, housing supply shifters, productivities, firm locations) fixed; firms re-optimize posted wages and the spatial equilibrium is recomputed.

ing those frictions raises firm-specific labor supply elasticities and compresses markdowns.

Two features of the pattern in Figure 12 are informative. First, the treated municipality exhibits large markdown declines underscoring how local access improvements move firm-level elasticities through the CMA channels rather than through productivity or amenities. Second, spillovers are geographically narrow: municipalities with already high CMA (central markets) change little, while those adjacent to San Bernardo exhibit modest markdown decrease as workers gain access to a thicker set of alternatives.

VIII. Discussion

Spatial frictions play a central role in how labor markets function. By shaping the set of outside options that workers can reach, commuting costs influence the degree of competition among employers and therefore the level of wages relative to marginal products. When access improves, workers face more employers, separations become more responsive to wage offers, and the wedge between productivity and pay narrows. The patterns in the data are consistent with this mechanism. Connectivity improvements raise mobility across local markets and lift wages even for workers who do not change jobs, which points to stronger outside options rather than pure sorting or firm specific productivity shocks. The geography of gains is also informative. Places that began with poor access exhibit larger wage increases and larger reductions in markdown, which indicates that limited mobility had sustained higher employer power in those locations.

The welfare implications follow directly. In spatial models with perfect competition, transport investments raise welfare by improving matches between workers and firms and by reallocating labor toward more productive uses. Once we admit wage setting power, there is a further source of inefficiency because wages fall short of marginal products. Reducing commuting frictions therefore delivers two gains at once. First, wages are closer to marginal products and there is a better overall allocation. Secondly, workers in the periphery and workers with lower skills start with the fewest accessible options and face the

largest markdowns, so they benefit the most when mobility rises. This is visible in the compression of spatial wage dispersion and in the larger gains for groups that were most constrained ex ante.

A policy implication from this paper is that transport investments operate as competition policy in the labor market. By expanding the set of reachable employers, they raise the elasticity of labor supply at the firm, move wages toward marginal products, and reduce inequality rooted in geography. Returns are largest where access is initially scarce, which implies that network design should prioritize links that connect peripheral neighborhoods to multiple employment centers. Standard cost benefit analyses that value time savings alone miss an important share of the surplus created by these projects. Incorporating the effect on wage competition raises the social value of connections that integrate thin markets and can change the ranking of routes and station placements.

The broader conclusion is that the spatial dimension is fundamental for understanding market power and its consequences. The same geographic frictions that segment urban economies also sustain markdowns that separate pay from productivity. Easing those frictions strengthens competition, raises average welfare, and delivers outsized gains to workers who were most constrained by where they live and the skills they possess.

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Supplementary Appendix

A. Additional Empirical Results

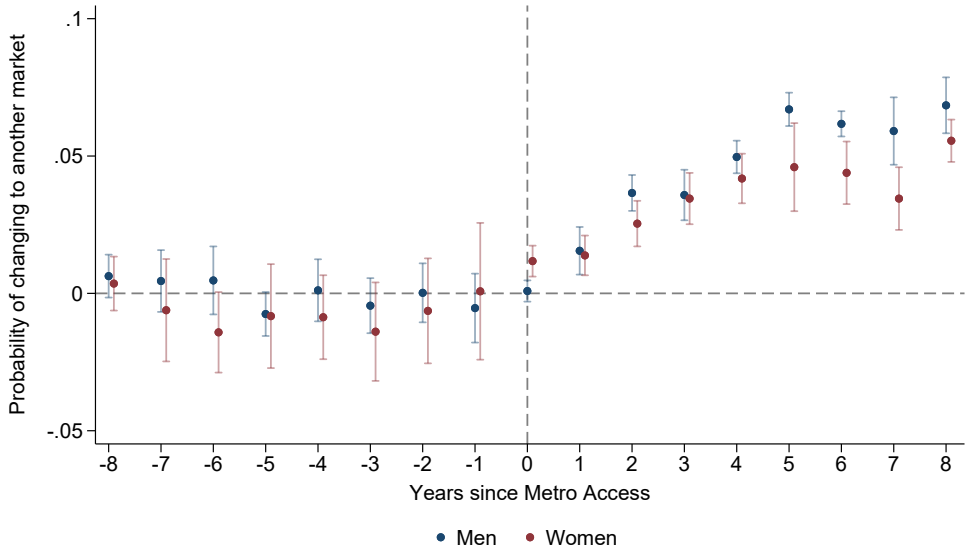
A.1. Reduced Form Results

Table 2: Probability of working outside own location and Metro Expansion

	(1)	(2)	(3)	(4)	(5)
	All	Men	Women	Non-college	College
Post=1	0.258***	0.224***	0.271*	0.276**	0.227***
	(0.0571)	(0.0284)	(0.131)	(0.0878)	(0.0216)
Post=1 × Time Reduction	0.00838***	0.00735***	0.00799*	0.00809**	0.0104***
	(0.00201)	(0.00147)	(0.00400)	(0.00308)	(0.000935)
Observations	5405	3512	1893	4052	1353

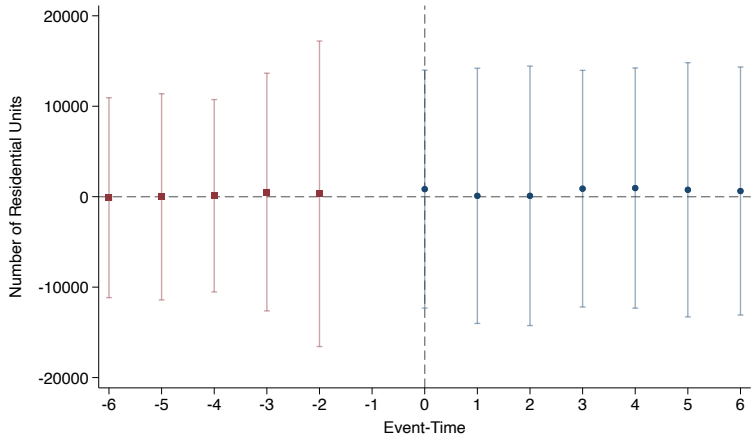
NOTES: The table displays the results of the static event-study specification, where we compare workers already treated with those that have not been treated yet. The dependent variable is a dummy that takes the value of 1 if the worker traveled outside their origin locality and 0 if he remained, and a set of interactions including post (i.e. if the worker was already treated or not yet) and time reduction as a measure for treatment intensity as the explanatory variable of interest. Columns (2) to (3) shows the results for the sample of men and women respectively. Columns (4) and (5) shows the results for non-college and college educated people respectively. Standard errors are clustered at the municipality level.

Figure 13: Cross Market Mobility and Metro Expansion: by Gender



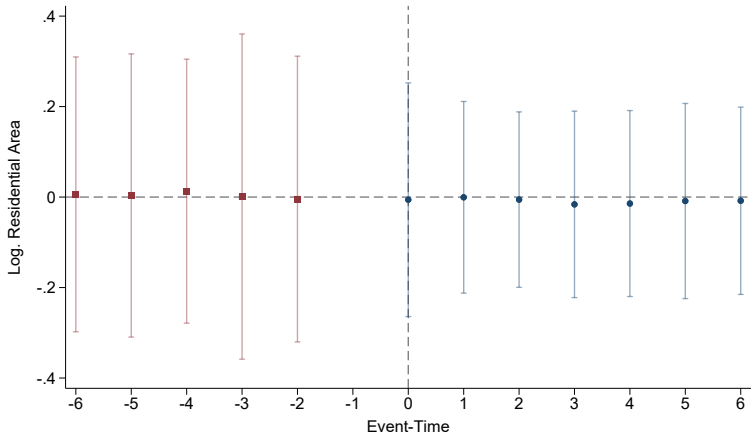
NOTES: Results of the dynamic event-study specification by gender, with cross-market mobility as the dependent variable and time to the introduction of the metro in the municipality as the explanatory variable of interest. Standard errors are clustered at the municipality level.

Figure 14: Number of residential properties transactions and the metro network expansion



Notes: *Results of the dynamic event-study specification using number of residential properties and time to the metro introduction in the municipality. Clustered SE at the municipality level.*

Figure 15: Residential floor space and the metro network expansion



Notes: *Results of the dynamic event-study specification using the log of the area dedicated to residential purposes and time to the metro introduction in the municipality. Clustered SE at the municipality level.*

B. Model Appendix

B.1. Additional Tables

Table 3: Mode Choice Estimates

	(1)	(2)
Parameter	**Estimate**	**Estimate**
s	0.0156^{***}	0.0168^{***}
	(0.00264)	(0.00273)
$\delta_{\text{hs,car}}$	0.618^{***}	0.745^{***}
	(0.156)	(0.148)
f_a	0.922^{***}	0.702
	(0.246)	(0.482)
Observations	2092	2092
Other Controls	No	Yes
Origin FE	Yes	Yes
Destination FE	Yes	Yes

NOTES: The table shows estimation results from logit regression on mode choices from trip-level data from the 2006 EOD Survey. Column (1) does not include other controls. Column (2) includes controls for departure time ranges, and dummies for gender and age range, which is equivalent to allowing preferences for each mode to vary by these characteristics. OD clustered standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Commute Semi-Elasticities (Aggregate)

	(1) All	(2) High Skill	(3) Low Skill
Parameter			
$s\gamma/\psi$	0.0417^{***}	0.0408^{***}	0.0438^{***}
	(0.00443)	(0.00727)	(0.00389)
N	431	184	237

NOTES: The table shows the estimation results of the gravity equation 12, estimated via PPML. The outcome is the log number of commuters between each origin and destination. All the estimations include origin and destination fixed effects. Reported coefficient is on travel time. Column (2) is only for low-skill workers. Column (3) is only for high-skill workers. Only trips to work are included. Origin clustered standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

B.2. Labor Supply Elasticity to the Firm

In this model, a firm's market power is inversely related to the labor supply elasticity it faces. The markdown (μ_{jx}) for a type-x worker at firm j is defined as:

$$\mu_{jx} = \frac{1}{1 + \varepsilon_{jx}} \tag{15}$$

where ε_{jx} is the wage elasticity of labor supply to firm j. To understand the sources of market power, we must decompose this elasticity.

The total change in labor supply to firm j from a change in its wage w_{jx} can be decomposed into two components, as seen in the model:

$$\frac{\partial L_{jx}}{\partial w_{jx}} = \underbrace{\sum_m D^h_{mx} \frac{\partial p^\ell_{j|xm}}{\partial w_{jx}}}_{\text{(1) Reach \& Preferences}} + \underbrace{\sum_m \frac{\partial D^h_{mx}}{\partial w_{jx}} p^\ell_{j|xm}}_{\text{(2) Resorting}} \tag{16}$$

In this appendix we decompose both of these terms.

B.2.1. Decomposing the "Reach & Preferences" Component

We isolate the first term from Equation 16, which captures how a wage change at firm j attracts workers from other firms, holding the residential distribution of workers constant.

$$\left.\frac{\partial L_{jx}}{\partial w_{jx}}\right|_{D^h \text{ fixed}} = \sum_m D^h_{mx} \frac{\partial p^\ell_{j|xm}}{\partial w_{jx}} \tag{17}$$

From the model, the probability $p^\ell_{j|xm}$ is a standard logit choice probability. The derivative of a logit probability with respect to its own utility component (w_{jx}) is:

$$\frac{\partial p^\ell_{j|xm}}{\partial w_{jx}} = \frac{1}{\psi} \cdot p^\ell_{j|xm} \cdot (1 - p^\ell_{j|xm}) \tag{18}$$

This derivative represents the sensitivity of worker choice. It is inversely proportional to ψ, the Gumbel dispersion parameter for firm preferences.

Substituting this back, we get a clean separation of terms:

$$\left.\frac{\partial L_{jx}}{\partial w_{jx}}\right|_{D^h \text{ fixed}} = \sum_{m \in \mathcal{M}} \underbrace{\left[D^h_{mx}\right]}_{\text{Term A: Housing}} \cdot \underbrace{\left[\frac{1}{\psi} \cdot p^{\ell}_{j|xm} \cdot (1 - p^{\ell}_{j|xm})\right]}_{\text{Term B: Labor \& Commuting}} \tag{19}$$

Breakdown of Decomposed Terms

Equation 19 shows that the derivative is a sum over all residential locations (m). The contribution of each location is the product of the *stock* of workers there (Term A) and the *sensitivity* of those workers to the wage change (Term B).

Term A: Housing Market

This term represents the equilibrium number of type-x workers living in municipality m:

$$D^h_{mx} = \mu_x \times p^h_{m|x} = \mu_x \times \frac{\exp\left((A_m - R_m + V_{xm})/\lambda\right)}{\sum_{m'} \exp\left((A_{m'} - R_{m'} + V_{xm'})/\lambda\right)} \tag{20}$$

This is determined by the Housing Market equilibrium. Its key components are: (1) the equilibrium rent price in location m; (2) the residential amenities in m; (3) the dispersion of residential preferences; and the expected value of employment from m, which links the labor and housing markets.

Term B: Labor Market & Commuting

This term represents the wage sensitivity of workers in location m. It is determined by the Labor Market choice. Its key components are: (1) The dispersion of idiosyncratic firm preferences, where a higher ψ (stronger preferences) reduces its value, increasing market power; (2) the firm's *market share of workers* from location m, where this probability implicitly contains the commuting desutility and the firm's wage w_{jx} relative to all other firms.

B.2.2. Decomposing the "Resorting" Component

The second term from Equation 16 is the "resorting" component. This term captures the additional labor supply a firm receives from workers who are induced

to *move their residence* in response to the wage change.

$$\left.\frac{\partial L_{jx}}{\partial w_{jx}}\right|_{\text{Resorting}} = \sum_m \frac{\partial D^h_{mx}}{\partial w_{jx}} p^{\ell}_{j|xm} \tag{21}$$

This term makes the firm's labor supply *more* elastic, thus *reducing* its market power. The core of this component is the derivative $\frac{\partial D^h_{mx}}{\partial w_{jx}}$, which represents the change in residential choice.

The housing demand for location m depends on its "attractiveness" relative to all other locations. Let $U_k \equiv A_k - R_k + V_{xk}$ be the attractiveness of any location k. The demand D^h_{mx} is a logit probability:

$$D^h_{mx} = \mu_x \frac{\exp(U_m/\lambda)}{\sum_{k'} \exp(U_{k'}/\lambda)} \tag{22}$$

To find the change in housing demand for m, $\frac{\partial D^h_{mx}}{\partial w_{jx}}$, we can apply the logit derivative formula:

$$\frac{\partial D^h_{mx}}{\partial w_{jx}} = \frac{1}{\lambda} D^h_{mx} \left[\frac{dU_m}{dw_{jx}} - \sum_{k \in \mathcal{M}} p^h_{k|x} \frac{dU_k}{dw_{jx}} \right] \tag{23}$$

This equation is key. First, it says that when the wage w_{jx} changes, it changes the attractiveness U_k for *all* locations $k \in \mathcal{M}$. Second, that the demand for location m increases if its net attractiveness rises by *more than the average* change in attractiveness across all locations. This explicitly captures the *other places' attractiveness*.

Given that $\frac{\partial V_{xk}}{\partial w_{jx}} = p^{\ell}_{j|kx}$, the total change in attractiveness for a location k is:

$$\frac{dU_k}{dw_{jx}} = \underbrace{p^{\ell}_{j|kx}}_{\text{Labor "pull"}} - \underbrace{\frac{dR_k}{dw_{jx}}}_{\text{Housing "push-back"}} \tag{24}$$

This shows the change in attractiveness is the net effect of the *pull* from better job access (from the wage hike) and the *push-back* from rising equilibrium rents

from increased demand.

Let's break it down:

- $\frac{1}{\lambda} D^h_{mx}$: This scales the effect. If λ is high (strong residential preferences), this term is small, and workers are "sticky" and do not move.
- $\left(p^{\ell}_{j|mx} - \frac{dR_m}{dw_{jx}}\right)$: This is the net change in attractiveness for location m. It's the "pull" from the higher wage ($p^{\ell}_{j|mx}$) minus the "push-back" from its own rising equilibrium rent ($\frac{dR_m}{dw_{jx}}$).
- $\sum_{k \in \mathcal{M}} p^h_{k|x}(\dots)$: This is the average change in attractiveness across all locations.

When w_{jx} increases, it raises the expected value of employment V_{xm} in all locations, with $\frac{\partial V_{xm}}{\partial w_{jx}} = p^{\ell}_{j|mx}$. This "pull" is strongest for areas close to the firm. As these locations become more attractive, housing demand increases and rents adjust upward, generating a "push-back" that limits the relocation of workers. The resulting elasticity reflects the balance between these two forces.

From above, we know that market power is highest when the resorting channel is weak. This occurs when:

- **Commuting frictions:** High commuting costs (d_{mnx}) make job access to j negligible for most m, weakening the "pull" term.
- **Housing frictions:**
  - **Inelastic housing supply ($\varepsilon \to 0$):** Any demand increase raises rents sharply, offsetting the wage effect and preventing reallocation.
  - **Strong residential preferences ($\lambda \to \infty$):** Workers are strongly attached to their homes, making $\frac{1}{\lambda}$ small.
  - **High amenities elsewhere:** Attractive alternative locations anchor workers even if access to j improves.

In summary, the resorting component links all three markets: the wage change (labor) is transmitted via commuting costs to the residential choice (housing),

which is itself mediated by housing prices and preferences.

B.2.3. Synthesizing the Components of Market Power

We can now combine these elements into a single expression that isolates the different sources of market power.

Let's define $\varepsilon_{jx}^{(\text{Local})}$ as the elasticity from the "Reach/Preferences" component (Section 2) and $\varepsilon_{jx}^{(\text{Resorting})}$ as the elasticity from the "Resorting" component (Section 4).

$$\varepsilon_{jx} = \varepsilon_{jx}^{(\text{Local})} + \varepsilon_{jx}^{(\text{Resorting})} \tag{25}$$

Deriving the Local Component:
First, we analyze $\varepsilon_{jx}^{(\text{Local})}$. We start from Equation 19 and multiply by $\frac{w_{jx}}{L_{jx}}$:

$$\varepsilon_{jx}^{(\text{Local})} = \frac{w_{jx}}{\psi} \cdot \frac{1}{L_{jx}} \left[\sum_m D_{mx}^h p_{j|xm}^\ell - \sum_m D_{mx}^h (p_{j|xm}^\ell)^2 \right]$$

By definition, the firm's total labor supply is $L_{jx} = \sum_m D_{mx}^h p_{j|xm}^\ell$. Substituting this into the first part of the bracket gives:

$$\varepsilon_{jx}^{(\text{Local})} = \frac{w_{jx}}{\psi} \left[1 - \frac{\sum_m D_{mx}^h (p_{j|xm}^\ell)^2}{\sum_m D_{mx}^h p_{j|xm}^\ell} \right] \tag{26}$$

Let's define $s_j \equiv \frac{\sum_m D_{mx}^h (p_{j|xm}^\ell)^2}{\sum_m D_{mx}^h p_{j|xm}^\ell}$. This s_j is a measure of how spatially focused the firm's hiring is, i.e., whether it draws workers from many locations or just a few. This leads to:

$$\varepsilon_{jx}^{(\text{Local})} = \frac{w_{jx}}{\psi}(1 - s_j) \tag{27}$$

The Three-Part Decomposition of Market Power:
Substituting this back into the total elasticity equation gives our final decompo-

sition:

$$\varepsilon_{jx} = \underbrace{\frac{w_{jx}}{\psi}}_{\text{(1) Job Elasticity}} - \underbrace{\frac{w_{jx}}{\psi} s_j}_{\text{(2) Commuting Friction}} + \underbrace{\varepsilon_{jx}^{(\text{Resorting})}}_{\text{(3) Housing Elasticity}} \tag{28}$$

This expression (Eq. 28) provides the clear decomposition. Writing out each component in its complete form, we have:

1. **Job Elasticity, traditional mechanism:**

$$\frac{w_{jx}}{\psi}$$

   This is the "traditional" or non-spatial component of elasticity, driven by idiosyncratic firm preferences (ψ), and represents the baseline elasticity.

2. **Commuting Friction:**

$$-\frac{w_{jx}}{\psi}\left[\frac{\sum_m D_{mx}^h (p_{j|xm}^\ell)^2}{L_{jx}}\right]$$

   This term is *negative*, meaning it *reduces* the total elasticity, thereby *increasing* the firm's market power. It is driven by commuting frictions (d_{mnx}). High commuting costs create a "concentrated" labor source, as the firm can only draw workers from a few nearby locations.

3. **Housing Elasticity (Resorting):**

$$+\frac{w_{jx}}{L_{jx}} \sum_m p_{j|xm}^\ell \left[\frac{1}{\lambda} D_{mx}^h \left(\left(p_{j|mx}^\ell - \frac{dR_m}{dw_{jx}}\right) - \sum_{k\in\mathcal{M}} p_{k|x}^h \left(p_{j|kx}^\ell - \frac{dR_k}{dw_{jx}}\right)\right)\right]$$

   This term is *positive*, meaning it *increases* the total elasticity and *reduces* market power. It captures the Housing Market interaction. As the firm raises its wage, it pulls workers to move into its catchment area. This effect is dampened by housing frictions (an inelastic supply $\varepsilon \to 0$ or strong preferences $\lambda \to \infty$), which make the rent response $\frac{dR_k}{dw_{jx}}$ large.