A Streetcar Named Opportunity
Can Light Rail Transit Foster Social Integration ?

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Abstract

By integrating social equity concerns and deviating from a traditionally more utilitarian design of transport networks, can cities reduce spatial inequalities ? This paper relies on an extensive multi-city Light Rail Transit (LRT) building program of the last two decades in France as well as a novel geocoded individual unemployed database to assess the effects of opening of a new transport option on individual unemployment trajectories and local social mixity. We find no evidence of any improvement in individual unemployment trajectories of the residents of the treated neighborhoods around the arrival of LRT. In the medium term we find effects on the housing market consistent with capitalization of accessibility gains as well as a change in income composition of renters although gentrification is limited by the large share of social housings.

Keywords: Local labor markets, Urban Transportation, Social Housing, Light Rail Transit

JEL classification: R23, R51, H21, H23

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1 Introduction

Investment in urban public transport, which amounts to a mere 16% of annual public investment in the OECD (CEMT, 2019) and more specifically to 20% in France in the last 20 years, rank among the largest investments made by local authorities. The resulting public transport infrastructure deeply shape the urban economy : first, they allow the separation of workplace and residence[1] and thus play a key role in the functioning of urban labor markets; secondly, they connect high density centers to the less-dense peripheries and are therefore instrumental in access to urban services and amenities for suburbanites, in particular for the most deprived ones[2]. Since it conditions access to both workplaces and urban services, public transport availability constitutes a key factor of social integration. In a context of urban segregation, policy makers and urban planers may thus be asked to take into account social justice concerns when designing and operating urban public transport networks. However, these investments are usually subject to explicit utilitarian planning through cost-benefit framework dating back to Dupuit (1844) and Hotelling (1938) that ignores social justice criteria[3]. By integrating social equity concerns and deviating from a traditionally more utilitarian design of transport networks, could cities reduce spatial inequalities ?

This paper contributes to assess empirically this question by investigating the changes in labor market integration, housing prices and population composition in deprived neighborhoods in response to the construction of a public transport network explicitly meant to connect the urban poor to the affluent city center. The French *"tramway revival"* over the last 20 years indeed offers a unique opportunity to empirically test the relevance of integrating social equity concerns when designing a transportation network. Between 1998 and 2018, 25 French cities have been building or extending their networks to the point where 27 of the 30 biggest cities in France are now equipped. One of the main stated aims of this policy was to fight the large, long lasting urban inequalities which characterize French cities.[4]

Indeed, when spatial segregation sorts deprived -or unemployed- urbanites in isolated neighborhoods, a positive shock in accessibility to urban opportunities in those neighborhoods supposedly

[1]See Heblich, Stephan and Redding, Stephen J. and Sturm, Daniel M. (2020) for an historical study of the emergence of this divide, that defines the modern metropolis.

[2]See Gabriel et al. (2015) for an explicit modelling of the interaction between endogeneous density-driven amenities and public transportation infrastructure. Glaeser et al. (2008) shows that these public transport is more valued by the urban poor.

[3]In France, for instance, the law stipulates that every public infrastructure must be evaluated ex-ante through economic modelling. The project cannot be authorized if social profitability, computed through a utilitarist framework, is not above a certain threshold. See Quinet (2013) and Boiteux (1994) for details.

[4]See Brueckner et al. (1999) for more precise a description of French spatial segregation.

fosters social integration, notably through better matching on the labour market or improved social mixity. However, the effect on the labor market is not straightforward. If better access to new job opportunities may result in more effective job-search, effective employment will also depend on skill-matching, that may have been affected by previous spatial isolation. Moreover, better connection to the city center may even make the local jobs more accessible for other deprived urbanites, reducing the rare local opportunities. Similarly, as newly connected locations become more attractive, housing and labor markets adjustments affect this direct positive effect in an ambiguous way. Housing prices capitalization and population change in response to such an accessibility shock may either result in the displacement of the most deprived out of the newly connected neighborhoods, which would deprive them of accessibility gains, or in an improved social mixity eventually beneficiary to employment and social integration in the long term through positive peer-effects.

We use the phased construction of French LRTs to identify effects of transportation on the fate of the most deprived urban area and their residents. To assess empirically the social effects of LRT networks, we combine several rich administrative datasets in an unique way that crucially allows to locate each individual's residence to precisely measure the impact of a new transport infrastructure. First, we recovered a unique and comprehensive dataset of the unemployed registering in their local job agency in 20 French cities from 2005 to 2019. This dataset includes addresses which we geocoded at a metric scale. Such infra urban precision has been missing so far in the literature to properly measure the impact of urban transportation on individual outcomes. Second, we further complement our analysis with transaction data on housing price and income composition at the block level.

We do not find any evidence of a change in individual unemployment trajectories around the arrival of LRT. Our estimation strategy, which relies on quarter to quarter change in unemployment outcomes around the arrival of the LRT, shows that treated and never treated area were similar before and ultimately after the arrival of LRT in the most deprived neighborhoods. Examining several relevant city and individual dimensions of heterogeneity confirms such results on every sub population. Importantly, such null effect is precisely estimated, leaving little room for economically relevant undetected effects. In our most precise estimates, the effect of LRT on the probability to have found a job after 6 month of unemployment is an insignificant 0.5 percentage point while the minimum detectable effect would be 0.8 percentage point. Crucially, while having no effect in the short term on unemployment outcomes we show that in the medium term LRT does have a strong effect on housing prices hinting at substantial gain in accessibility. Interestingly this rise in housing prices induces the displacement of low-income renters in the private sector but does not affect the large part of the population living in social housing. Taken together, this results show that a large part of the population of treated neighborhoods have benefited from a gain in accessibility while gentrification has been limited by the important and growing numbers of social housings.

This paper is linked to the spatial mismatch literature that underlines the role of the physical disconnection of workers from job opportunities to explain spatial inequalities in unemployment outcomes (Kain, 1968). Such mismatch is notably reinforced by urban segregation for ethnic minorities and deprived households. Using observational data, several early studies find a correlation between job opportunities accessibility and unemployment in American (Stoll and Raphael, 2000; Rogers, 1997) and European cities (Dujardin et al., 2004; Matas et al., 2010; Gobillon et al., 2011). However, the rare natural experiments analyzing an exogenous change in households location hold contrary results on the existence of a causal link (Kling et al., 2007; Åslund et al., 2006). Our study builds upon this literature by focusing on deprived neighborhoods inhabited by immigrant descent population for who spatial mismatch ought to be particularly acute. The result of this literature also guide our heterogeneity analysis of population for whom accessibility matter the most (Women , Non French Resident etc...). Our paper contributes to this literature by studying the effects of public transportation improvement, which is widely seen as a potential solution to spatial mismatch. Indeed, theoretical contributions have proposed that shorter or cheaper transportation could positively affect job prospects by increasing the radius of search, reducing the net commuting cost wage (Coulson et al., 2001; Brueckner and Zenou, 2003), and increasing the productivity of the worker (Zenou, 2002). However despite this theoretical mechanisms, few studies brought causal evidence of such link (Bastiaanssen et al., 2020). Two RCT show that reducing the cost of public transportation for cash constrained individuals improve their job prospects in the short term in Washington and Abu Dibba ((Phillips, 2014; Franklin, 2018)). Closer to our work, three papers have aimed at studying the effect of the construction of a new infrastructure. In the American context Holzer et al. (2003) study the expansion of a heavy rail system linking Oakland to its southern suburbs and show that firm located near a newly built station tended to hire more Hispanic workers but not Black. Using French census data Sari (2015) study the effect of the opening of a LRT line in Bordeaux and shows that linked area have seen a reduction in unemployment rate. However the nature of his data does not allow him to distinguish between composition effect and change in individual job accessibility. Closer to our work, using panel data and an Intention To Treat design Åslund et al. (2017) do not find any effect of a new commuter train in Sweden on the population present before the opening. We believe our study reinforce this result as we focus on larger infrastructure project and vulnerable population which are at the center of the Spatial Mismatch Literature. Our study also confirms a null effect in a multi city design avoiding the city specific results which hinder the rest of the literature.

This paper also participates to the literature studying population sorting and home price capitalization in response to transportation infrastructure. The effects of a new public transit option on population sorting are not straightforward. While many studies from Gibbons and Machin (2005) on late 1990s' London to Ahlfeldt and Wendland (2009) on 1890–1936s' Berlin showed that households have persistently valued accessibility gains through rail [5], which should result in attracting wealthier households in treated neighborhoods, Glaeser et al. (2008) argued that public transportation infrastructures could act as a poverty magnet, attracting the urban poor that place a far greater value in rail access than wealthier populations, due to their lower car ownership rate. However, if the effects of public transit on housing prices have been extensively studied (see Debrezion et al. (2007) for a review), empirical studies that examine neighborhood and social effects of public transit remain scarce and inconclusive[6]. In a study over American cities that built public rail transportation infrastructure, Kahn (2007) found contrasted effects of a new transit option on home prices and proportion of college graduates : six of the fourteen cities exhibit a positive and statistically significant effect, while two exhibit a negative one ; moreover, in most cities, the positive effect appears to be larger in neighborhoods whose prices were below the median before treatment. Such phenomenon, usually driven by a relative affluence of in-movers, is known as gentrification (Freeman, 2005). Using income, occupation, degree, ownership and rent to define gentrification, Grube-Cavers and Patterson (2015) found a positive effect of transit exposure on gentrification in two of three Canadian cities having recently invested in a new transportation infrastructure[7]. By contrast, Dong (2017) found no evidence of gentrification in Portland in response to the opening of a new public transit network, and even show that public transport attracted older and less-educated population. More recently, Tsivanidis (2018) proposed a general equilibrium model that explains the contrasted responses of affluent and deprived populations to a new infrastructure depending on road congestion and jobs geography. He argues that although deprived households are dependant to public transport, high-skilled workers -who exhibit a high value of time- may put a higher value on public transport in case of high congestion. On the Bogota TransMilenio BRT case, he provides evidence of population change in connected areas benefi-

[5]Billings (2011) and Bardaka et al. (2018) study light rail-transit in the cities of Charlotte and Denver in the United States, and provides evidence of similar effects for LRT than from other commuter railways.

[6]See Padeiro et al. (2019) for a literature review

[7]A positive effect in Toronto and Montreal, but none in Vancouver

ciary to high-skilled workers, consistent with this mechanism. The contribution of our paper to this literature is thus two-fold : (i) it constitutes the first attempt to explicitly describe gentrification in the most deprived neighborhoods after the introduction of a new transit option, which offers an opportunity to further examine the preference of the urban poor for public transit signalled by Glaeser et al. (2008) (ii) it expands the growing corpus of European studies, so far limited. Among two papers among the 73 reviewed by Debrezion et al. (2007) cover the European case, while only five out of 35 studies gathered by Padeiro et al. (2019) are not US-based. European cities nonetheless differ largely from their American counterparts, especially on public transportation that is much more common and developed. In particular, the French case is of interest since 23 Light Rail Transit networks built in the last 20 years are French among 138 built worldwide.

More generally, as a whole, this paper exploits the specific focus of French public transport on deprived neighborhoods to assess the pertinence of such a deviation from the utilitarian planning framework. It thus contributes to provide empirical evidence to feed a long-lasting discussion on the equity-efficency trade off in public good location choice (Thisse, 2007). In a seminal paper, Morrill and Symons (1977) point out that an efficient location pattern *à la* Dupuit (1844) that maximizes system profits or minimizes travel costs may result in socially unacceptable inequality in access over space owing to area variations in density and income. By contrast, Glaeser and Gottlieb (2008) argues that, in a spatial equilibrium framework, equity-motivated place-based policies only contribute to moving populations to low-amenity places, and show that there is very little evidence of the efficiency of such policies. Thus, equity concerns should lead to people-based and not place-based policies, which supports the utilitarian approach. Finally, Tsivanidis (2018) empirically exposed that even when infrastructure is designed to connect the urban poor, welfare gains are better captured by high-skills, affluent workers, since improved connectivity led to travel time savings but also to a reorganization of residence and employment location choices. While the low-skilled use public transit the most, their value of time remains low and they may be replaced in newly connected neighborhoods by the high-skilled, who exhibit a higher value of time. However mainly empirical since we do not develop a theoretical framework to compute welfare gains for connected populations, our contribution to this literature is two fold : (i) it constitutes to the best of our knowledge the first empirical analysis to focus simultaneously on labour and housing market effects of public transit in the most deprived neighborhoods, which allows to clearly identify the sources of welfare changes for the most deprived populations; (ii) it constitutes the first study to explore a particular feature of European cities : the large presence of social housing, and the possibilities it offers for a mixed public transport and housing policies.

The remainder of the paper is structured as follows. Section II discusses the institutional backgrounds of Priority Neighborhoods and LRT constructions programs. Section III presents the data as well relevant descriptive statistics for treated and non treated groups. Section IV exhibits reduced-form evidence that the LRT arrival had no short term effect on individual unemployment trajectories. Section V describes the housing market capitalization of the accessibility shock and the mid term social mixity effects Section VI concludes.

2 Institutional Background

2.1 Deprived peripheral neighborhoods in France : a persisting issue for urban policy

Urban segregation in French cities has been a perennial issue for urban and social policymakers for decades. The post-war housing crisis lead to anarchic development of large housing compounds at the fringe of every French city in the 1950's and 1960's : *Les Grands Ensembles* (The Compounds), built for car-owners of the then-emerging middle-class with limited connections to urban transport networks or city centers (Newsome, 2004). Those housing complexes experienced important shift in social composition in the 1980's when the middle class moved to city centers, followed by progressive relocation of low income populations in those ageing complexes, which left French cities to deal with large, spatially isolated deprived neighborhoods at the fringe of the major metropolitan areas.[8]

The Priority Neighborhood : a zoning policy Facing rapidly increasing urban inequalities, French policymakers have historically relied on zoning to define placed based policies. Among the many zoning policies defined since the 1990's, the most important and particularly well evaluated since it was used for local tax incentives and enterprise zones[9] was the "Sensitive Urban Zone" (*Zone Sensible Urbaine* - ZUS) defined in 1996. It was replaced in 2016 by "Priority Neighborhood" (*Quartier Prioritaire de la Ville* - QPV).

Contrary to the ZUSes that were determined jointly by local and state officials based on qualitative criteria (presence of *Grands Ensembles*, unemployment level, etc.), the QPVs are defined on quantitative criteria which aimed at both avoiding political interference and ensure high similarity among the neighborhood to allow for evaluation of local policies. 1296 "priority neighborhoods" were defined by the French National Statistical Institute (INSEE) on the basis of the 2010 census. They regroup 5 million

[8]For an comprehensive history of these neighborhoods, see also Burgel and Jullien (2014)

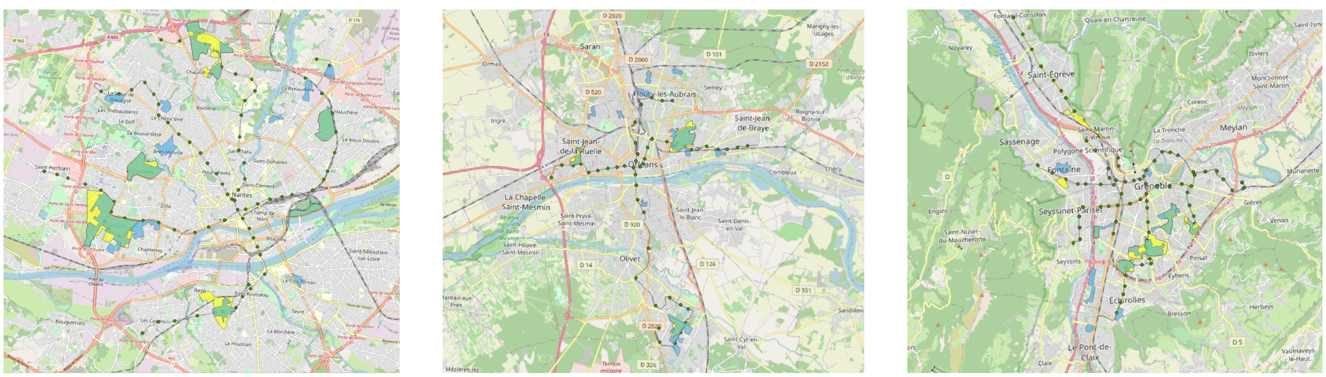
[9]See Briant et al. (2015) or Gobillon, Laurent and Magnac, Thierry and Selod, Harris (2012)

inhabitants in 702 different municipalities. They were defined using 2010 census data by

- a median income below a threshold defined by :
  - $S = 0,6[(0,7NationalMedianIncome) + (0,3CityMedianIncome)]$ for urban units larger than 5 million inhabitants
  - $S = 0,6[(0,3NationalMedianIncome) + (0,7CityMedianIncome)]$ for the others
- a population larger than 1,000 inhabitants

However different in their definitions, the similarities of these two zonings are striking : if QPVs are smaller and more numerous than ZUS, they cover very similar zones. In our cities of interest, 92% of the ZUS (299 of 326) defined in 1996 have a 2010 QPV in their perimeter as can be seen in Figure 1. Permanence of urban segregation and spatial isolation (Briant et al., 2015) may explain such persistence.

Figure 1: Nantes, Orleans and Grenoble LRT, QPVs and ZUSs



Note : QPVs are displayed in blue, ZUS are in yellow, tram stops are circles in green.

Source : BD-TOPO & Open Street Map

The Priority Neighborhood inhabitants Population composition is very similar across those compounds due to the definition of the zoning. These urbanites face multiple obstacles in both the labor market and housing market. First and forefront stands geography: most of these territories are located at the outskirt of cities and are often surrounded by physical barriers such as railway lines or highways as exemplified by Briant et al. (2015). Such spatial isolation, coupled with lower car ownership, translates into lower mobility and higher reliance on public transportation (Nicolas et al., 2018). A second obstacle is social. These neighborhoods' inhabitants are more likely to have immigrant backgrounds and suffer from a discrimination in the labor and housing market due to their origins and the bad reputation of their neighborhoods (Mathieu et al., 2016; Bunel et al., 2017). Finally, as documented by descriptive statistics in Section III, they are also less educated and skilled than the rest of the population. These difficulties translate into higher poverty, unemployment and crime prevalence which are higher in those neighborhoods than anywhere else in metropolitan France. More specifically, at the beginning of our period of interest in 2005, 22.1% of deprived neighborhoods' residents were unemployed compared to 11% at the national level.

Besides zonings and placed based policy, another lever to reduce spatial inequalities for local authorities has been transportation policy, which aim at reducing isolation of deprived neighborhoods.

2.2 Light rail transit in France : a revival motivated by social equity concerns

Tramways as an urban policy toolbox If electric tramways were common in European and American cities in the early 20th century, they been totally disappeared after World War II due to the combination of low fuel prices, rise of individual car and a correlated shift of public investment towards road construction (Goddard, 1996). At the end of the 1980's, French cities initiated a Light Rail Transit revival (locally known as *Tramways*) through an unprecedented nation-wide consistent program[10]. By contrast with previous public transport infrastructure built in France, this *tramway revival* appears largely motivated by increasing social concerns linked to urban segregation, which makes it of particular interest for our study.

Indeed, the LRT program represented a pivotal moment for french doctrine on urban transportation decision-making. France transport infrastructure policy had been carried out throughout the whole territory since the 18th century by central-state administrative body, the *Ponts et Chaussées* (Picon, 1992, 1994) whose decisions relied notably on utilitarian cost-benefit analysis following the tradition introduced by Dupuit (1844) and continued by Colson (1924)[11]. The 1982 Deferre decentralisation bill suddenly moved the authority on public transportation from the all-powerful hands of central state to municipal authorities, which paved the way for better assessment of local political priorities in infrastructure projects (Thisse, 2007; Offner, 2001), including social equity concerns. Lévêque (2017) showed for instance on the case of Lyons' metropolis that connection of deprived neighborhoods to

[10] see Appendix A.1 for a brief history

[11] This framework introduced by French transport engineers (Roy, 1940) was popularized among English-speaking economists by Hotelling (1938).

the city center has been a constant goal of local transportation schemes since the mid-80s. Similarly, the first LRT networks to be rebuilt in Nantes in 1985 and Grenoble in 1987 were explicitly aiming to connect deprived peripheries to affluent city-centers. The popular success of these pioneer LRT made it one of the most popular urban planning tools among mayors nationwide to tackle the issues of congestion and urban segregation. Between 1998 and 2018, more than 25 cities in continental France built or extended LRT networks adding up to 600km of tracks and 800 stations (for a complete list of built lines and projected networks see figure A.3 in Appendix A.1). In most cities, LRT usage has exceeded by far the initial target.

Over the period in France, LRT constructions were the most important public investments by local authorities[12]. This national trend for LRT building appears as the most striking example or a world-wide movement in which 138 new LRT networks were built worldwide in the last twenty years, more or less explicitly mirroring the French experience.

Table 1: Bus, LRT, and metro performances

	Bus	LRT	Metro
Max. flow (p/h)	700-1000	2000-5500	> 8000
Frequency (s)	600	180	100
Speed (km/h)	10-13.5	19,6	30
Cost (M euro/km)	5-10	15-30	45-100

Source: CEREMA (2019) study on 2002-2014 projects and FNAUT (2016)

LRT : comparative advantages The success of LRT with policy makers and commuters stems from its relative advantages compared to the bus and the metro. For mid size budget-constraint cities it brings some of the advantage of the latter in term of confort and frequency but at a fraction of the cost. Faster, more frequent, and only 3 time more expensive than the Bus, LRT circulate on their own tracks and benefit from priority at crossing, which is particularly advantageous to avoid congestion. Table 1 recall theses advantages. Sadly, there is no source of data which would allow use to easily compute the gain in travel time [13]. Anecdotal evidence show that they often are substantial. A rough approximation can

[12]For instance, the tramway of Dijon, considered as one of the least expensive, cost up to 400 million euros, which amounts to four times the annual investment budget of the whole metropolitan area of Dijon

[13]the decentralised administration of urban public transportation network by local transport agency make the gathering of the information very costly. Some city may have kept old matrices of distance in public transportation but it is not certain and recovering them would require stinking data access agreement with each agency individually

be drawn under the hypothesis that the LRT simply replace a Bus line. Given the difference in speed, traveling from two points on the line would take between 49% and 31% less time than with a bus. The time gain are potentially even more important at pick hours when LRT benefit the most from its corridor.

A common design inspired by a redistribution criteria Most of the networks are very similar in their design. Tramway lines are radial; they connect the central neighborhoods to the fringe of the continuously built area, passing through large avenues[14]. Table 2 report some descriptive statistics about network design. We observe that most (77%) tramway works can be considered as new lines openings that exhibit a mean 18 stops per line, a 11,4 km length and a mean distance of 630 m between stops. Such long line openings supposedly create a significant accessibility shock to the city center and, depending on the existing network, the rest of the city. By contrast, line extensions are generally short and should be excluded from our analysis. LRT lines also follow a common pattern by connecting points of interest (POI) such as the main hospital, airports and train stations, town halls, large commercial malls and, if applicable, universities, as shown by Table 3.

Table 2: Descriptive statistics on 1815 stops on realized LRT projects in the period of interest

	New Lines	Extensions
Distance between stops (m)	630	375
LRT line length (km)	11,4	-
Number of stops	18	5
Share	77%	23%

Source: BD-TOPO and authors' own computations

However, an analysis of the political discourse around the construction of the LRT shows that beyond utilitarian gains in travel time, the French LRT investment pursued a clear social equity objective: connecting the lower-income neighborhoods to the affluent city centers and the rest of the city (Pissaloux and Ducol, 2012). Figure 2 exhibit constructed networks maps that reflect such objectives : we can see that QPV are quasi systematically connected, even at the cost from a deviation from direct center to periphery route or extension to areas that exhibit no specific POI. Table 3 similarly suggests that LRT tend to be diverted from utilitarian objectives such as connecting POIs to connect deprived neighborhoods. Thirty years after the beginning of this nationwide trend, many *Quartiers de la Politique*

[14] where they often follow the ancient tramway track

de la Ville in large French cities were indeed connected to an LRT network as shown by figure 4. In cities where the network reconstruction started early (such as Strasbourg, Nantes or Grenoble), 80% to 90% of the QPVs are finally connected as for today.

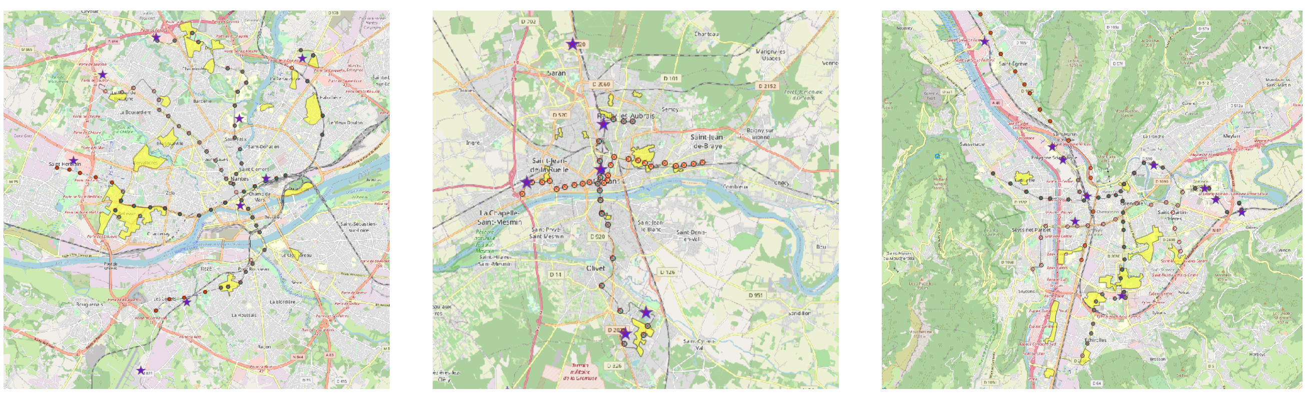
Furthermore, heavily subsidised fare and generous mean tested social pricing are traditionally offered by local transport agencies to alleviate cost barriers for low income users [15]. The French experience thus appears a case study of a transportation infrastructure designed with equity concerns in mind, beyond classical public transport utilitarianism.

Table 3: Peripheral destinations reached by tramway lines connecting QPVs

Destination	Airport	University	Hospital	Rail	Stadium	City hall	Large Malls	Any
All Tramway Stops	6.5%	11.7%	10 .3%	8.7%	3%	0.7%	37.3%	78%
Stops connecting QPVs	3.7%	6.7%	4.4%	4.4%	5.2%	0.7%	42.6%	67%

Source: Authors'own calculations from BD-TOPO.

Figure 2: Nantes, Orleans and Grenoble LRT, Priority Neighborhoods and POIs



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Note : QPVs are displayed in yellow, tram stops are circles and stars stand for POIs.

Source : BD-TOPO & Open Street Map

The French public transport infrastructure decision process Since 1995[16], every new infrastructure is indeed subject to a public debate. This typically corresponds to the first public information on the possible routing options. The chosen route, that must take into account the results of both the cost-

[15] In 2019, on average, the normal monthly fare was around 50 euros and the lowest social fare around 7 euros (for a summary of pricing by city see in A.1 in Appendix)

[16] *Barnier* Law of environment protection and local democracy, voted February 2nd, 1995

benefit andlysis and public debate is then issued in the official gazette[17], which allows to launch heavy works and the necessary expropriations. The mean delay between the publication of the chosen route and the line opening is 3,48 years. The delay between public debate and line opening is more volatile, however the mean project being completed 4 years after public debate[18].

3 Data and Empirical Strategy

3.1 Data

We combine several comprehensive administrative datasets that describe job, transportation and housing markets at individual or city-block level to assess the effect of an LRT network on deprived neighborhoods. This unique database extends over 14 years and exhibits granular spatial precision, which crucially enables to document change around the arrival of LRT at an infra urban scale.

3.1.1 Unemployment data

Unemployed individuals Our unemployment data set contains the universe of the unemployed registered at their local unemployment office between April 2005 and December 2018 (corresponding to a total population of 123,161 unemployed in our neighborhoods of interest, and more than 20 million nationwide), their socioeconomic characteristics, education, unemployment history, benefit eligibility, job search sector, maximal radius of search (expressed in distance or time) as well as postal addresses upon registration, drawn from *Pôle Emploi*'s (French Unemployment Agency) *Fichier Historique* (FH) data set and completed with the outcomes of several internal working databases.

Censoring and Outcome of Interest Job seekers are required to notify their job agencies every month that they are still looking for a job to keep their status. Additionally, local job agencies are aware if job seekers find a job only if they declare it upon deregistration. As a result a well-known shortcoming of this type of data is that we cannot always know for sure if job seekers stop registering because they have indeed found a job or only because they failed/forgot to notify their job agencies. Job seekers entitled to UI benefit are strongly encouraged to stay registered as it is a necessary condition to receive

[17] This "*Déclaration d'Utilité Publique*" (Declaration of Public Utility) can be issued either by central authorities such as the "*Section des Travaux Publics*" of the "*Conseil d'Etat*" or by regional state representatives, the "*préfets*".

[18] See Appendix A.3 for more details.

their benefits but many are not eligible[19]. Table 4 reports the motives for termination of registration.

Table 4: Motives for termination of registration

Motive	Share of all exits
Find a job	20%
Exit to non-employment	15%
Unknown destination	56%
Incomplete spells	8%

Source: Fichier Historique 2005-2018

We address this shortcoming in two ways. First to avoid the cases where people unemployed simply forget to notify their agencies a given month, a spell is considered as terminated if job-seekers do not register again at *Pôle Emploi* in the following month. Second, we define two individual outcomes not affected by censoring and a block level outcome which correct for it. For each individual spell we compute both the probability to have exited unemployment after 6 months, irrespective of the exit type and the share of days spent registered in unemployment in the two years following a registration. The latter allows us to capture potential longer term effect of the LRT not only on the chance of finding a job but also the quality and durability of the match. Finally to take into account the information on the exit types, we estimate a simple Kaplan Meier estimator of survival at 6 months for each quarter of registration - block cells where we set all incomplete spells at the end of the period and unknown destination to right censoring while defining two competing risks for "finding a job" and "exiting to non-employment". We then define a corrected probability to have found a job with certainty at 6 months for an individual living in place j as $P(Job)_j = 1 - \hat{S}_j$ where $\hat{S}$ is the Kaplan Meier survival into joblessness at 6 months.

Geocoding Although crucial to a precise identification of the effect of public transportation on the labor market, infra-municipality data remain scarce in the literature. To the best of our knowledge, we are the first to use metric-scale geocoded data to describe urban labor markets. Using a phonetic string fuzzy matching algorithm on a comprehensive database of postal addresses, we are able to associate up to 85% of spells with the coordinates of the job seeker's residence[20]. Figure 3 reports the output of this process on a small neighborhood. Precision of the coordinates found is actually sufficient to

[19]In our population of interest many job seekers are only eligible to the unconditional welfare benefit

[20]See appendix B.1 for details

identify not only the building but also the staircase of residence of the unemployed.[21]. Geocoding allows to measure individual distance to the closest LRT stop upon registration.

Figure 3: Unemployed geocoded at residence by our algorithm in Le Havre's eastern QPV.

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Source : Administrative dataset, authors'geocoding and Open Street Map

3.1.2 Block level Data

To describe the mutations of a neighborhood's population induced by an LRT, we turn to block-level aggregated variables. We define a city block by the most precise spatial unit available in the French cadaster, the *Section Cadastrale*.[22]

[21] Access to the exact postal addresses is restricted for legal reasons and has been possible thanks to the unemployment agency general direction. The final dataset contains only distance to LRT stops upon registration and not geographical coordinates

[22] The median cadastre area is 257420.9 square meters which approximately corresponds to a 500*500 meters square

Population Composition We retrieve population characteristics at the block-level from a fiscal database on the universe of population and housing stock (*Fichier des Logements par Communes*, henceforth FILOCOM) available every two years over 2000-2014 at the French Ministry of Housing. It gives information on each non-commercial dwelling every two year between 1995 and 2015. It displays the location of each dwelling, its surface and whether it is rented, social housing or owner-occupied. It also contains the number of person who live in it, their age and income. For privacy constraints the data set do not contains information on blocks of less than 10 households.[23]. It allows us to recover income, age and household composition in each block, to document the evolution of the composition of the populations of deprived neighborhoods following the arrival of the LRT. Cadastral map is not constant over time and sections can be yearly redrawn by municipal authorities. However, using dwelling identification allows to follow changes and construct constant sections. Moreover, dwelling identification being held constant over time, one can use it to characterize population flux at block level.

Housing market We exploit administrative PERVAL database from the French Board of Notaries (*Chambre des Notaires*) to further characterize the evolution of the neighborhoods through the housing market, it records transactions on the housing stock every two year from 2000 to 2014, localized at block level and with detailed information on both the dwelling's characteristics and the buyer and seller status and occupation. Notary records provide a representative sample of the French housing market[24].

3.1.3 Light Rail Transit

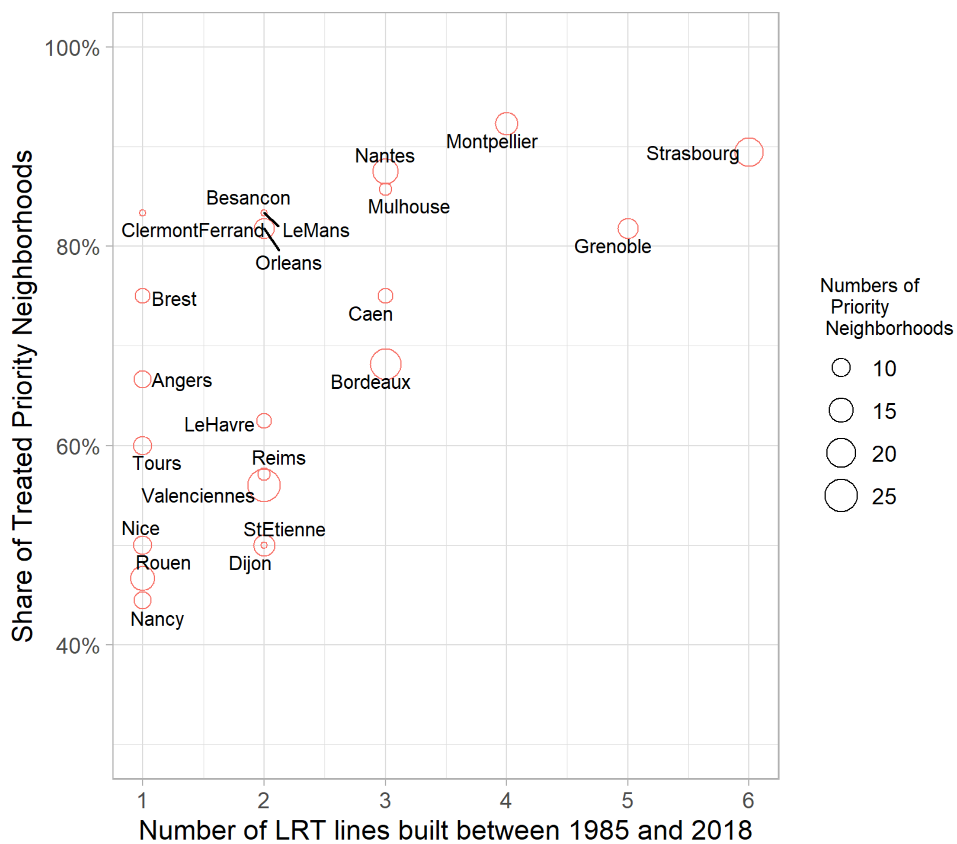
LRT being dedicated to local transit, stations are closer than those of heavy rail networks and lines may be extended more gradually. Spatial and temporal precision is thus necessary to describe their phased development and its effect on urban labor markets. To do so, we built a comprehensive GIS database of LRT stops' openings on a daily basis from 1985 to 2018. Geographic coordinates at a metric level are drawn from annual editions of the French National Geographic Institute (IGN) database BD-TOPO, supplemented and corrected when necessary with local transport authorities archive maps. Timing of decision, construction and entry into service is very well documented thanks to the administrative

[23] Such limitation is of little importance in our urban settings. In our population of interest, a median of 1105.5 individuals live in one block

[24] According to INSEE (2014) the data base covers more than 60% of the universe of transactions and constitutes an adequate sample that does not exhibit harmful biases.

process for infrastructure building. If each stop precise opening date can be easily drawn from local transportation authorities archives, we also have high quality data on the whole local decision process, which allows to also identify when the chosen route is known to the public. We build a panel of city blocks covering our period of interest, and compute the distance to the closest tramway stop at each time of the network's evolution. Figure 4 reports descriptive statistics on this development, on which it appears that the cities that pioneered the tramway renewal (Nantes, Grenoble, Strasbourg, Montpellier) exhibit a quasi total coverage of their QPVs by a LRT stop, while more recent networks, that only exhibit few LRT lines are still in the process of achieving such a coverage.

Figure 4: City share of treated QPVs vs. number of lines built btw 1985 and 2018



Note : this graph represent the City Share of Priority Neighborhoods located at less than 500 m from a LRT stops in 2018 for cities for which LRT and not the metro is the main historical transportation mode

Time-span and spatial extension of the analysis Considering the historical depth of these datasets, a common period of interest that allows us to compare the effect of an LRT on both unemployment trajectories, housing prices and population composition lies between May 2005 and September 2014.

The revival of the tramway started in the 1980's and lasts until today[25], as a result many neighborhoods among French LRT cities have been connected before or after our period of interest. We do not consider these openings in our analysis.

Moreover, to further ensure comparability between the different tram openings we study, we chose to exclude three cities : Paris, Aubagne and Valenciennes. This choice is notably motivated by the specific design of those networks. The Parisian LRT network is not radial and tend to link peripheries between themselves, which complicates the job market analysis. Aubagne network is a subnetwork, but only a few kilometers long in a peripheral municipality in the larger Marseilles metropolis that for local political reasons is not connected to the remainder of the metropolis network. Valenciennes network, by contrast, connects two cities of equal sizes and exhibit a 20-km interurban section with no stops between two city centers of equal size that make it more similar to a commuter train than a LRT.

3.2 Empirical Strategy

3.2.1 Identification

As showed *supra*, French LRT developments explicitly targeted deprived neighborhoods and especially QPVs in a redistribution-motivated deviation from utilitarian planning. However, as new infrastructure is costly, not every *QPV* has been connected to the city center during our period of interest. This offers an opportunity to estimate the impact of the connection of a deprived neighborhood to an LRT network by comparing connected and non connected neighborhoods in a quasi event-study[26] specification at the individual, dwelling or block level.

Are these neighborhoods comparable? The selection procedure of the QPVs ensure high comparability between these neighborhoods. Beyond, our period of interest stands in the middle of LRT development roadmaps in most treated cities : potential bias arising from comparing the first connected neighborhoods, that may have been chosen out of local unobserved urgency, with the last connected or never connected ones, is thus tampered. Finally, Figure 6 shows that connected and non-connected *QPV*s during our period of interest are actually very similar in levels and trends over most outcomes before our period of interest. This parallel pre-trends identifying assumption is verified in practice on every outcome of interest as showed *infra*.

[25]The last LRT line opening at the date of submission is Caen new tramway, on July 2019

[26]actually more a staggered difference in differences as exposed *infra*.

Discussion on Causality *Stricto sensu*, these estimates would be causal if connection of a QPV with an LRT during the period of interest is quasi-random and does not correlate with unobserved characteristics of the neighborhoods that would have an effect on our outcomes of interest. Similarity of pre-trends between treated and non treated QPVs stand in favour of this identifying assumption.

However, LRT developments are not random since we have seen they also aim at connecting train stations, hospitals, city hall, stadiums or large malls altogether. Far from threatening our strategy, this feature can actually be seen as a source of quasi random variation in LRT development since it is easier to provide LRT service to *QPV*s located between these points of interest, a location arguably unrelated to local neighborhood-specific unobserved characteristics. Table 5 shows that connected *QPV*s are more likely to be on a route to a POI than non connected ones.

Table 5: Peripheral destinations reached by large radial roads connecting QPVs to city centers

Destination	Large mall	Airport	University	Hospital	Rail	Stadium	City hall	Any
LRT connected QPVs	35.6%	3%	5.9%	5.2%	5.2%	3%	0.7%	58%
Non LRT connected QPVs	5.4%	1.4%	3%	0.7%	0%	1.2%	0%	11.7%

Note: Authors'own calculations from BD-TOPO.

For a *QPV*, being closer to a convenient route from the city center to a POI increase the probabilities of connection to the LRT. Though, since we have seen the average LRT line is 11,4 km long, being on a convenient route from the city center to a POI does not *a priori* imply better *ex-ante* access to the POI itself. It thus constitutes a factor of quasi-random variation in *QPV* connection unrelated to unobserved characteristics. However, we are not able to use explicitely this exogeneous variation to instrument our results in the spirit of the inconsequential units approach developed by Chandra and Thompson (2000), since it would come at the cost of a large reduction of our set of pertinent LRT stops[27], which would threaten the precision of our estimators.

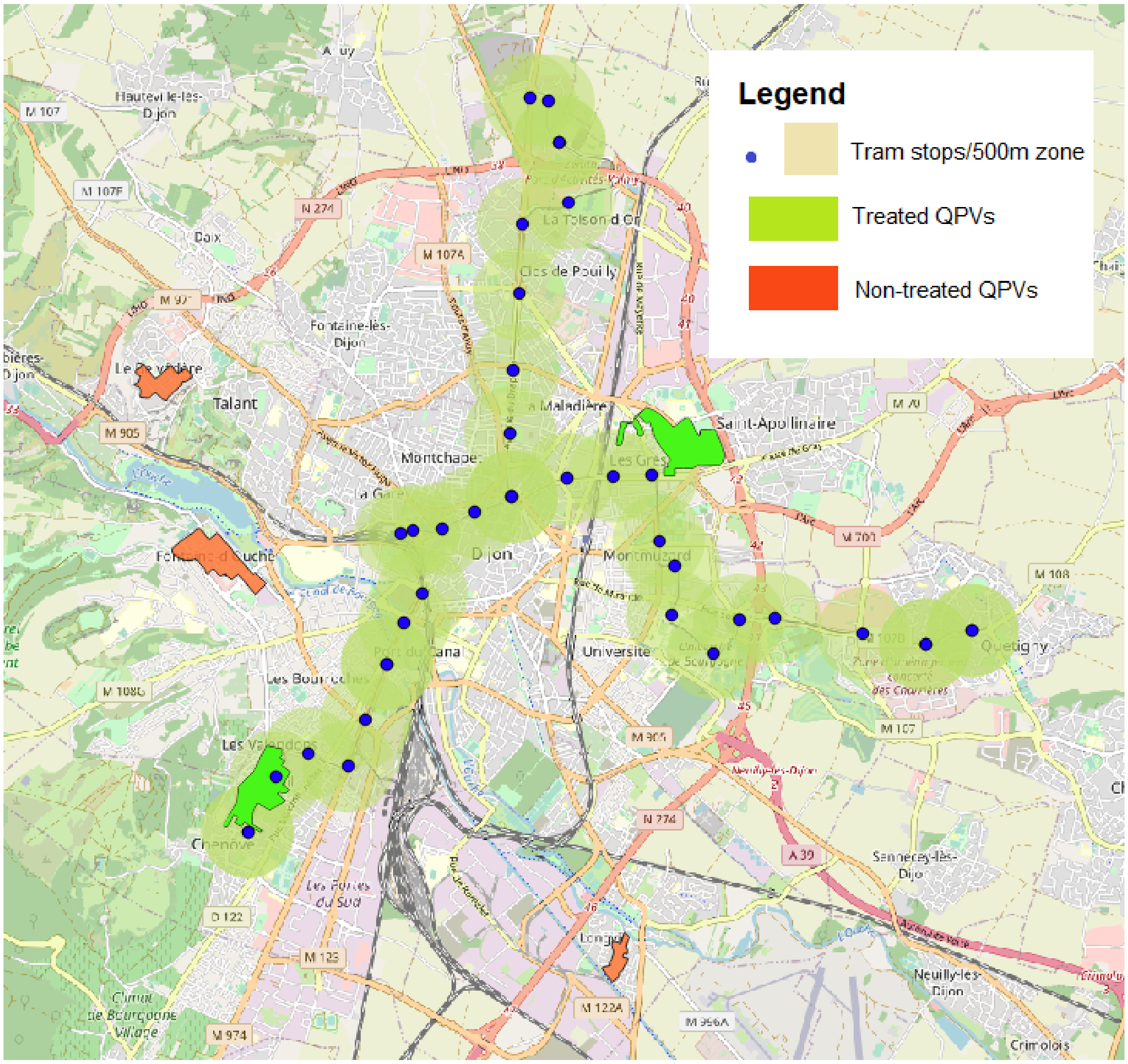
3.2.2 Treatment

Definition of treatment We follow transport economics literature to consider a neighborhood and its residents treated when a LRT stop is opening at less than 500 meters from its border. Our control group is made of neighborhoods which are not treated at that time (no LRT stop have been built at 1000 meters from the border of the block). We exclude areas yet treated by another rail infrastructure, should it be subways (Lyon, Marseille, Toulouse and Rennes exhibit metro lines) or existing tramways.

[27] Actually less than half QPVs of interest are on a way to a POI.

Figure 6 shows treated and never treated groups for the city of Dijon, Burgundy.

Figure 5: Treated and Never treated Neighborhoods in Dijon



Data: BD-TOPO & Open Street Map

To further take advantage of the preciseness of our data in the case of unemployed, we consider them treated if and only if they live in a treated block and their own individual distance to LRT next stop becomes lower than 500 meters. For the block analysis we define as treated a block intersecting a priority neighborhood area and located at less than 500 meters from a tram stop. This restriction aims at increasing the potential detected effect by focusing on the individuals and blocks which benefited the most from the new infrastructure.

These restrictions leave us with 195 treated blocks and 152 control blocks in 20 cities

Zoning discussion The use of zoning defined on the 2010 population census, during our period of interest could be a problem if LRT had a drastic short term impact on location decision of households. Descriptive statistics show that urban geography of poverty being quite persistent over time, treated and non treated priority neighborhoods were already very similar and quite poorer than other neighborhoods in 2005.

3.2.3 Estimation Strategy

Our identification strategy relies on multiple tramway line openings in different cities at different times. We compare the evolution of several outcomes for the unemployed, households and transactions around the arrival of the LRT. We thus estimate the following individual and Block level regression with a balanced panel :

$$Y_{i,t} = \sum_{-8<k<8} \beta_k D_{l(i),t,k} + \gamma X_i + \lambda_{l(i)} + \mu_{j(i),t} + \epsilon_{i,t} \tag{1}$$

$$Y_{l,t} = \sum_{-8<k<8} \beta_k D_{l,t,k} + \lambda_l + \mu_{j(l),t} \epsilon_{i,t} \tag{2}$$

Where $Y_{i,t}$ is the outcome of an individual i (unemployed, household, transactions) in period t, k is the difference between t and the date of opening of the tramway in the neighborhood, $\lambda_{l(i)}$ and $\mu_{j(i),t}$ are respectively a block l and a city j - year fixed effects and X_i is a vector of individual controls. $D_{l,t,k}$ is a dummy that values 1 if a LRT line was opened in the vicinity of block l in k quarters before time t.

This estimation relies on within-city comparisons of blocks treated at the beginning of the period of interest with both blocks treated at its end and never treated blocks [28]. Our estimation is akin to a "stacked" difference-in-difference

The coefficients β_k can thus be interpreted causally under the common trend assumption : in the absence of the LRT, treated and non-treated blocks and individuals in the deprived neighborhoods would have evolved similarly. The specification allows us to examine such assumption by observing if the outcomes evolve differently between treated and never treated in the periods leading up to the tramway arrival.

The analysis on population composition and housing prices focuses on a -6,+6 year window. As we only have data from 2000 to 2014 on housing prices the event we could study with those two data sets

[28]In practice few cities have several events in our period of study and our identification mostly rely on a comparison between treated and never treated blocks for a list of event refer to the appendix

and a balanced panel is limited to the event occurring in 2006 and 2007. Meanwhile, The short term analysis of unemployment outcomes study the effect of the LRT in the 6 semesters before and after the opening of the infrastructure and rely on data available from April 2005 to January 2019. Taking full advantage of our data we carry the short term unemployment analysis both for the entire period of availability of the data (reported in the main text) and for the common opening of 2006 and 2007 (reporter in appendix).

3.3 Descriptive statistics

Table 6: Summary Statistics - Population Mean (standard deviation) before LWT arrival

group	Treated	Never Treated	General population
Age	30.4 (10)	30.8 (10.2)	30.8 (9.9)
Women	0.5 (0.5)	0.5 (0.5)	0.52 (0.5)
Years of Experience	2.46 (4.94)	2.86 (5.41)	3.09 (5.62)
University Degree	0.17 (0.38)	0.15 (0.36)	0.31 (0.46)
No degree	0.56 (0.5)	0.55 (0.5)	0.43 (0.5)
Managers	0.03 (0.18)	0.03 (0.17)	0.09 (0.28)
Skilled employees	0.5 (0.5)	0.52 (0.5)	0.57 (0.5)
Unskilled employees	0.47 (0.5)	0.45 (0.5)	0.35 (0.48)
French Nationality	0.81 (0.39)	0.85 (0.35)	0.89 (0.32)
P(Still registred after 6 mth)	0.44 (0.5)	0.45 (0.5)	0.44 (0.5)
P(Still registred after 2 y)	0.43 (0.32)	0.44 (0.32)	0.41 (0.32)
P(job with certainty 6 mth)	0.14 (0.07)	0.15 (0.09)	0.19 (0.12)
Housing Price/m2	1582.8 (463.5)	1674.5 (413.1)	1971.5 (473.8)
Median Income	7880 (2283.9)	7683.3 (2357.1)	10826.4 (2884.9)
Share social housing	0.47 (0.34)	0.51 (0.29)	0.19 (0.25)
Dwellings Surface	69.6 (15.9)	78.2 (17.5)	71.4 (19.4)
Number Transaction	29 (43)	18 (20.4)	23.5 (27.6)
Turnover rate	5,1%	3,2%	4,1%
Population	16176	7288	123161

Notes : Statistics from jobseekers registering in their local agency in the second quarter of 2005 Housing variables and Joblessness Survival are block level mean weighted by the number of unemployed living in the blocks in each group

Individual labor market characteristics Looking at labor market relevant characteristics of the treated and never treated populations shows inhabitant of Priority Neighborhoods to be very comparable while reflecting the hurdles they face in finding a job. The Table 2 presents some descriptive statistics for the job seekers entering unemployment before the arrival of LRT (in the second quarter of 2005) in the two groups as well as for the rest of the population living in our cities of interest. As expected unemployed people living in Priority neighborhoods are both less educated and less skilled than the general population. Only 15% and 13% of them hold a University degree and strikingly they were respectively 56% and 55% to have failed to validate their last Diploma. At the same time they are under representation in managing position and over representation in unskilled workforce. Finally they less often hold French nationality than the general population which hint but understate the representation of immigrant descent worker in Priority neighborhoods.

Block level characteristics Housing and income variables also support the comparability of our population and underline stark differences with the rest of the population. Housing prices and median income are very similar in treated and never treated blocks and respectively about 20% and 33% lower than for the rest of the population. Furthermore job seekers in our population of interest live in blocks where almost half of the dwellings are social housing.

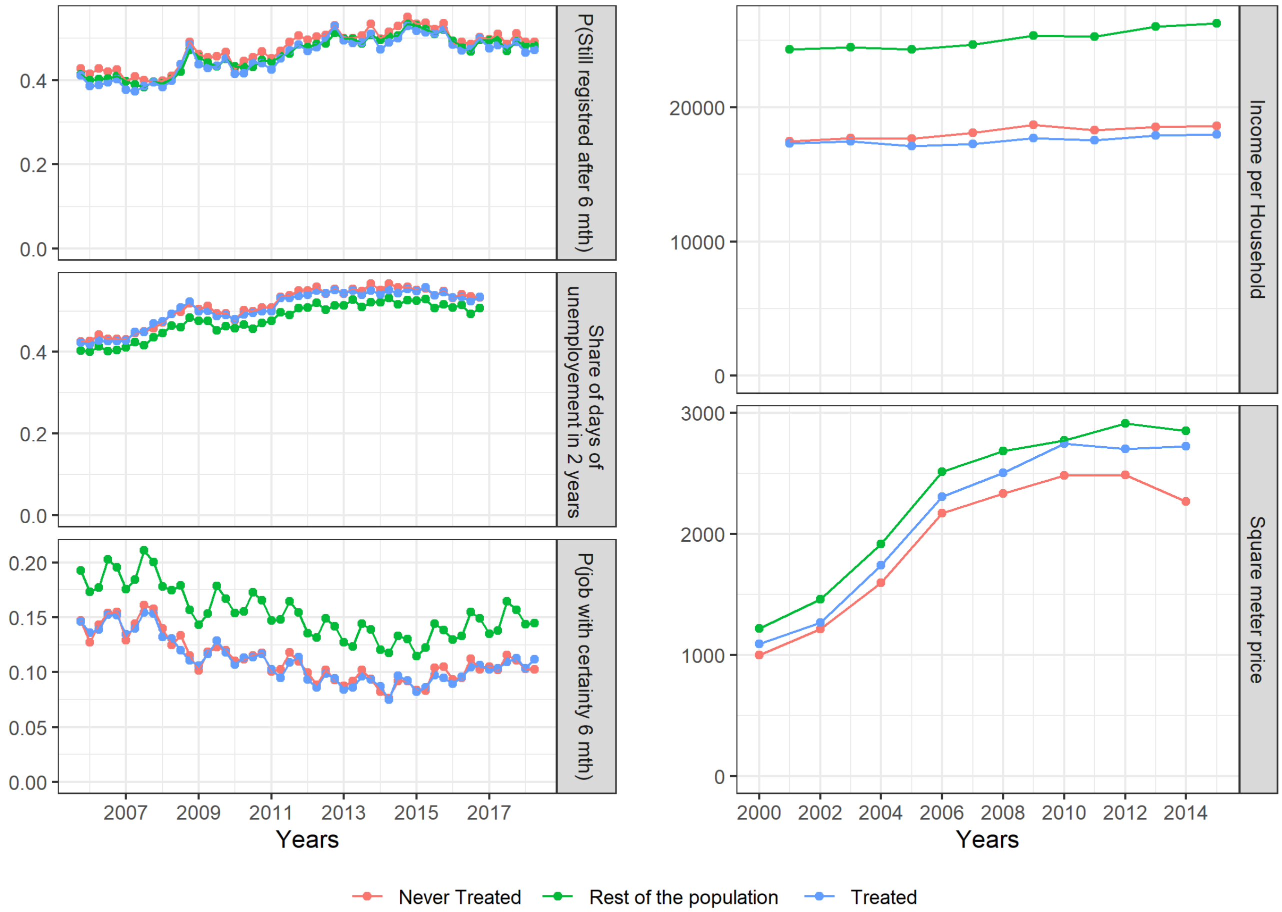
Outcomes of interest In addition to Table 2, Figure 6 plots the evolution of the different outcomes throughout the period of interest. It confirms the similarity of the two groups and reflects the existing gaps in job market outcomes. The differences are stronger when looking at the block level probability to have found a job with certainty. Once censoring corrected in the second quarter of 2005 we find that only 12 and 13% of the job seekers have found a job with certainty whereas 17% of the general population did, which amounts approximately to a 30% difference. Both the never treated and the treated curves are almost confounded whereas the gap with the rest of the population remains big for the entire periods.

The gap between the share of days in unemployment of the two populations is smaller at the beginning of the period but grows slightly, notably during the 2008 crisis. Interestingly Registration status at 6 months does not hold the same pattern between the three groups.

Housing outcomes show more interesting patterns as the difference between treated and never treated groups initially negligible increase after opening of the LWT in 2006 and 2007.

This first graphical analysis confort the comparability of treated and control group . It also show that the scope for an average effect of LRT on labor market outcomes is limited while mid term housing

Figure 6: Outcomes of interest through time



Left panel: Group mean for job seekers registering a given quarter from the 2005 to 2018 for the full sample of openings. Two calendar years of data being necessary to compute the share of days spent in unemployment we can only compute it up to the end of 2016. The probability to have found a job with certainty is equal to 1-Kaplan Meier survival in Joblessness.

Right panel: Group mean for households and transaction in a given year from the 2000 to 2014 for the openings of 2006 and 2007.

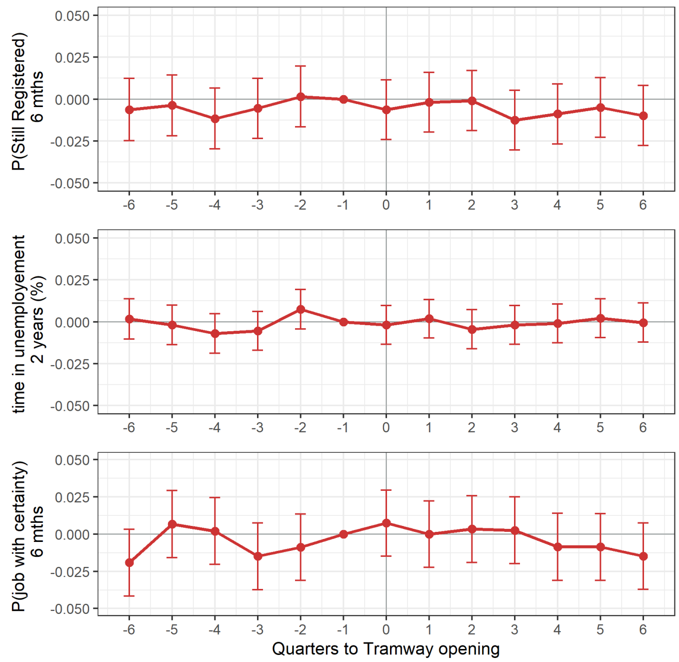
Source: FH 2005-2018 - Perval 2000-2014 - FILOCOM 1999-2015

market variable seems to respond to LRT connectivity in the decsriptive stats.

4 An access to jobs ? Unemployment trajectories with a new transit option

Labor market integration in the most deprived neighborhoods constitutes a cornerstone of social effects of transport policies, since it may both be influenced by public transport availability and constitute a proxy for broader social integration.

Figure 7: Labor market outcomes and LRT arrival



Notes: this graph plot the $beta_k$ of equation 1. Interpretation : the job seekers entering unemployment 4 quarters after the arrival of LRT in their neighborhood are 0.1 percentage points (non significative) less likely have found a job 6 months of unemployment than jobseekers living in untreated neighborhood.
IC: 95% Confidence interval Source: FH - full sample

4.1 Dynamic setting

4.1.1 Results

The figure 7 plots the results of the main regression for our 3 outcomes of interest. All outcomes exhibit a similar pattern. The profiles of the plotted lines are essentially flat. There are not differences in the periods preceding the LRT arrival which validate our pre trend hypothesis and our empirical strategy. Furthermore, There are no detected change in the unemployment outcomes after the arrival of the LRT in a neighborhood. The null effect suggested by the figure 6 is here confirmed by our regression results. The standard errors are fairly small, which leaves little room for an economically significant and undetected effect of the LRT on the entire population

4.1.2 Identification Hypothesis

Two potential identification concerns could have plaged our analysis.

First, both the control and treated group are located in the same city, and an improvement in the accessibility and job prospect of one group could have a negative effect on the second group through spill over on the labor market, thus violating the Stable Unit treatment value assumption (SUTVA). Such violation would bias our estimates upward, overestimating the aggregated benefits of LWT on employment and is not much of a concerns given our null results.

A second concerns arise if an improvement in job prospect of the population living in treated block is due to a change in composition and not to the LWT per se. Our analysis controls for an extensive number of individual characteristics such as any bias would come from change in unobserved characteristics uncorrelated with observable. Furthermore, the literature and the second part of this article documents that gentrification is a long term process taking years if not decades to fully materialize **?**. By comparison, the very short run nature of our analysis should shield us from big change in the population. Finally here again, if anything the bias should lead us to overestimate the effect of the LWT as more affluent households move in the treated neighborhoods.

4.2 Heterogeneity

Aggregated results point to a null effect of the arrival of LRT on labor market outcomes. But specific population, which theory or the empirical literature identifies as being more likely to benefit from increased accessibility, could benefit from LRT.

4.2.1 Estimation Strategy

To better asses the potential heterogeneity of our effect without lossing too much preciseness we aggregate unemployment spell before and after the arrival of LRT and carry a simple difference in difference strategy.

More precisely, as we focus mainly on outcomes define in the 6 first months of unemployment, job-seekers registering in the two quarters before the arrival of a LRT have access to this new transport mode at the end of their spell and are partially treated. We thus restrict our analysis to job seekers registering in 3, 4, 5 and 6 quarters before and 0, 1, 2 and 3 quarters after the arrival of LRT. The non treated group is here made of job seekers residents in never treated blocks or in blocks to be treated more than 12 quarters later.

We carry analysis along individual, block and cities dimension of heterogeneity. We thus interact an heterogeneity dimension dummy with the treatment dummy of the difference in difference specification as well as with with city*quarter and block fixed effect. The coefficient associate with treatment is then interpreted as the deviation of treated job-seekers of groupe h relative to their city-heterogeneity group trends after the opening of the LRT.

Many block*quarters cells contain few unemployment spells resulting in the impossibility to compute Kaplan Meier estimates for specific sub-groups. We thus do not estimate individual dimension of heterogenity for this outcome

4.2.2 Dimension of Heterogeneity

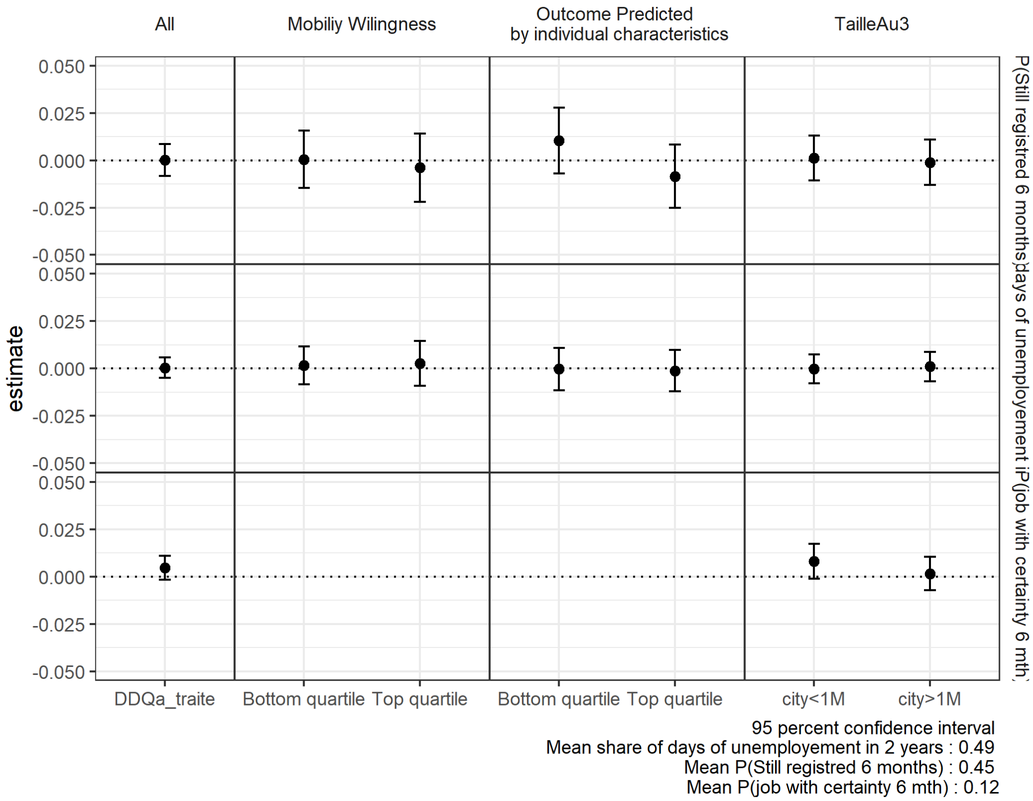
We test for several relevant dimensions of heterogeneity :

Commuting potential A new transportation infrastructure could have an heterogeneous effect depending on the mobility potential of job seekers. During their registrations meeting at their local agency, job seekers are asked to state what is the maximum distance they are willing to commute to work. They answer a distance in km or a commuting time but do not specify what is their transportation mode. To test if the LRT affects differently job seekers depending on their commuting willingness we build city specific quartile of commuting willingness and run the regression for the different quartile (only top and bottom quartile specific effect are reported). To complement this analysis we also run the regression for two sub population that are known to be particularly limited in their commuting potential : Mothers ((Petrongolo and Ronchi, n.d.)) and handicapped job seekers (result reported in section B of the appendix)

Predicted outcomes The spatial mismatch literature hints that the population that has the worst predicted labor outcomes also tends to be the most affected by a low job accessibility (Labor outcome of low educated women in Barcelona and Madrid are more sensitive to job accessibility compare to high educated women as showed by Matas et al. (2010)). To test if LRT affects differently job seekers depending on their expected labor outcomes we use our extensive set of control co-variates to estimate a predicted outcome and build city specific quartile groups.

Georgraphic Heterogeneity Change in transportation modes could have different effects in big and small cities. For example, congestion problems tend to increase with city size. LRT network are build to avoid part of the traffic jam at peak hours and could thus provide a bigger accessibility gains in bigger cities. Big cities are also by definition more geographically extended making the potential job accessibility gains more substantial. To test for such heterogeneity we divide our cities of interest in

Figure 8: Heterogeneity analysis



Notes: this graph plot the *beta* of equation 1 for several dimension of heterogeneity.

Scale and IC: scale are fixed at -10% and +10% of each outcome mean; 95% Confidence interval

Source: FH

two groups depending on their size [29]. We also run the analysis for treated blocks located at more or less than 5 km from the city center (see appendix)

4.2.3 Results

The results of the heterogeneity analysis of the effect of LRT are summarized in Figure 8 and in the Figure B.2. The left columns presents the results of the difference in difference estimation for the full population without heterogeneity dimension. The subsequent columns present the results of the estimation for the three heterogeneity dimensions previously defined.The results confirm the full population results. Most point estimates are very close to zero in absolute terms and relative to the mean of each outcome. Furthermore, At a 95% interval none of the coefficients are significant

[29]Size size is define using the Urban Area population (Aire Urbaine)

while the coefficient for small city is marginally significant at a 90% test. In Appendix B.2, Figure B.1 presents results for the DD estimation dis-aggregated per city,here again at 95% very few estimate are significant.

4.3 How precise is this zero ? A comparison

Table 7: Difference in Difference estimates

	Dependent variable:		
	P(Still registred 6 months)	Number of spells 1 year	P(job with certainty 6 mth)
	(1)	(2)	(3)
LWT	0.0001	0.0004	0.005
	(0.004)	(0.003)	(0.003)
Minimum Detectable Effect	0.011	0.007	0.008
Mean Outcome	0.45	0.49	0.114
Observations	255,849	255,849	5,985
R^2	0.135	0.141	0.418
Adjusted R^2	0.133	0.138	0.334

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
statistical significance a = 0.05; statistical power (1 <U+0392>) = 80 percent

Table 3 present the difference in difference point estimates and standard error of regression 1 on the entire population. The point estimates are very small, respectively representing 0.2%, 0,4% and 4.4% of the population mean and are insignificant at standard level. This null result is precisely estimated

Directly comparing the size of our results to the literature is not easily done as few contributions are closely linked to ours. Nevertheless given the level of preciseness of our estimates we would have been able to detect the effect presented elsewhere in the evaluations of programs designed to reduce unemployment duration. Closely related to us albeit in a different context, Phillips (2014) shows that the the job finding rate of job seekers who randomly received a public transit voucher in Washington increases by 5 percentage point after 3 months. In the French context and with a similar population of interest, Behaghel et al. (2014) find that an public intensive counseling programs reduce the number of days spent in unemployment in the year following registration of 20.6 days (4.8 percentage points) for those who entered the program and and by 6.5 days (1.8 percentage points) for those assigned to the program. More generally, active labor market policy tend to have bigger effect than our minimum detectable effects. Card et al. (2010) find that in average, counseling scheme increase the probability of finding a job by 2 percentage points in the medium term (1 to 2 year after program completion), training by 6,6 and private subsidy by 6.2 [30].

Even the most precise estimates would not allow us to conclude that LRT constructions do not have any effect on labor market outcomes in the short term. However if such positive effect existed and remained undetected its size would be of little economical relevance. This results complement the results of Åslund et al. (2017) while focusing on a particularly vulnerable population across many cities.

From a labor policy perspective our results underlines that improvement of public transportation, an intuitive and theory backed solution to spatial mismatch, does not always translate in better labor trajectories. As already stated, inhabitants of Priority Neighborhood face multiple challenges to labor integration and increasing accessibility to the rest of the city seems not to be enough to improve their unemployment trajectories.

From the lens of optimal public transportation design, this results show that deviating from an utilitarian design to take into account social fairness should not be founded on the sole expected gains in term of labor integration on the most vulnerable.

5 An improved social mixity ? Capitalization and population displacement

Increased access to central amenities and jobs makes a previously isolated neighborhood more attractive. The net present value of all future benefits of this accessibility improvement (in terms of time, fuel, comfort etc.) shall reflect on a rise in the value of properties around the tramway stops. Such capitalization constitutes indirect evidence of the efficiency of the new transit network and that the zero-effect identified *supra* is not due to insignificance of the accessibility shock. Housing market adjustment could also induce population displacement that may impact social integration of treated neighborhoods initial inhabitants. Such population displacement actually reduces the aggregated welfare gains of the urban poor from the infrastructure but in the same movement improves social mixity, which may induce peer effects favorable to social integration in the long term. The overall impact is actually highly dependent on the local situation of connected neighborhoods : the housing occupation status, owner or social tenant rather than private tenant, is key to the ability of initial inhabitants to capture welfare improvements linked to an accessibility shock. Our fiscal and transaction datasets

[30] those estimates are averages of positive, null and even negative effect programs

allows to assess these impacts.

5.1 Estimation strategy

We follow the estimation strategy presented in Section III to follow housing market evolutions as well as changes in occupant income and buyer and seller occupation. Since the effects on the housing market appear more salient on the medium term, we use a two-year time span [31].

Considering that we have extensive data on dwelling characteristics, we assess medium term effects on the housing market by estimating an hedonic equation similar to Equation 1 on all transactions[32]. To assess population displacement in response to treatment, we estimate the staggered differences in differences specification presented in section III on the outcomes of interest available in fiscal data: inhabitants, newcomers and departing income as well as population flux. Occupation data in our transaction dataset offers complementary evidence. Eventually, we are able to focus on pertinent heterogeneity dimensions, such as social housing presence, distance to CBD and city size.

5.2 Results

5.2.1 An accessibility shock that capitalizes into prices

A strong market capitalization Considering that QPVs rank among the most deprived and isolated neighborhoods in town, the expected rise of housing prices is not straightforward. Lower local amenities reflected by the initial deprived status could translate in a lower price increase than observed in the general case. However, due to higher previous spatial isolation (as pointed out by Briant et al. (2015)), accessibility improvement after LRT connection could be larger and lead to higher price increase.

Hedonic prices estimates are presented in Figure 9. We find strong evidence of a capitalization of the accessibility shock, through a significant effect on housing prices as of the first year of operation, up to a 10% increase in housing prices six years after treatment. Absence of pre-trends is coherent with our common trends identification hypothesis. This immediate strong effect constitutes indirect evidence of the amplitude of the accessibility shock provided by the new infrastructure. The fact that, nonetheless, it did not produce any improvement on the labor market situation of treated inhabitants is thus very informative. To give a sense of comparability, Baum-Snow and Kahn (2000) find that

[31] which corresponds to the seasonality of our data.

[32] Hedonic price models are extensively used to examine whether home prices have increased in areas where public transit access has improved (Debrezion et al., 2007).

decreasing distance to transit from 3 to 1km made housing prices rise by 4972 dollar per square meter in large US cities, whereas the meta-analysis by Debrezion et al. (2007) exhibits impacts ranging from -7% to +36%, with a +8% mean impact. Our 10% estimate is coherent with these findings, slightly larger than the mean point estimate in the literature, which would be coherent with the hypothesis of a large accessibility improvement due to LRT in *QPV*s.

No anticipation Interestingly, we do not find any sign of anticipation. However, as exposed in Section II, complete pre-works information is given by public enquiry and issuing of a *Déclaration d'Utilité Publique* by state authorities, in a mean 3.48 year delay before the LRT entry into service. We expect anticipation to take place in this time-span and it should thus, if existent, appear in our pre-trends. Absence of anticipation may indicate that investors are not confident in the capitalization of accessibility benefits, which could be actually hampered by (i) persistent bad reputation; (ii) path dependency of neighborhood sorting as exposed empirically by Heblich et al. (2016) on English cities of the industrial era. However, the absence of pre-trends constitute evidence supporting the idea of possible 'redlining' of these neighborhoods, that could partly explain their inhabitants persistent difficulties to labor integration even after connection.

Another feature supporting this hypothesis is the absence of new constructions that would increase the housing stock as reported in Figure C.1 in Appendix C.1 since it potentially reflects investors expectations as well.

Appendix C.3 reports the results of similar specifications restricted to existent housing, to wash out any possible effect of new buildings or increased quality. The price increase is robust to these restrictions.

Heterogeneous effects across cities If the rise in housing prices reflects a shock in accessibility to the rest of the city, it should vary accordingly across cities. In particular, it is expected that small cities where congestion is low exhibit higher substituability between public transport and individual driving. By contrast, in large cities, high congestion and parking fees makes individual driving an option unavailable to the urban poor. We therefore expect accessibility gains to be larger for neighborhoods living farther away from the city centers of in large, congested cities. Table in Figure 9 reports the results of a difference in difference estimation following a similar specification as in section III. This figure provides complementary evidence of capitalization of an accessibility shock since we observe a larger rise in prices in the largest cities (more than 1 million inhabitants). Similarly, the increase of housing prices is higher in neighborhoods located more than 5 kilometers away from the city center.

Figure C.6 in Appendix C.3 exhibits the results of the same specification restrained to cities under 400,000 inhabitants, cities ranging between 400,000 and 800,000 inhabitants and cities beyond 800,000 inhabitants.

Market activity To test whether this price increase is driven by an increase in demand, we turn to occupation duration and number of transactions reported in the Perval database. Figure 10 reports the results. We find a significant effect on the number of transactions on the year of treatment, and a non significant increase in the point estimate afterwards. More significantly, we find a negative and growing effect on occupation duration up to a 5 months reduction (-20%) after 6 years. Turnover on the housing market is thus significantly augmented by connection to the LRT.

Since we do not have census data with a precise enough time-span to enable us to track urbanites in and out our tiny neighborhoods of interest[33], we have to make the hypothesis that the turnover on the housing market we reported is a good proxy for the migration flows. Therefore, we can use population inflows and outflows from the FILOCOM database as a proxy of real population displacement. Obviously, it comes at the price a small biases such as neglecting internal migration, however the small size of our neighborhoods of interest make such a migration quite uneven *a priori*. These figures motivate a closer look at the characteristics of households entering and leaving the newly connected neighborhood.

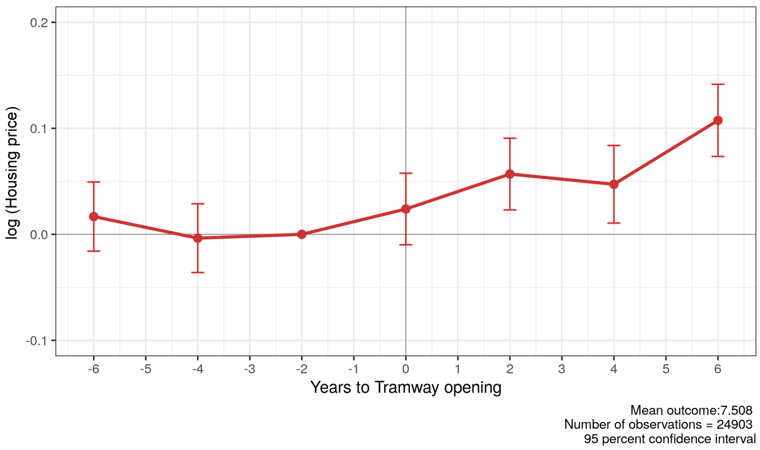
5.2.2 Population change through migrations

As deprived neighborhood are better connected to the city centers, external households are willing to locate in the treated area. The amplitude of these flux, and whether this new population differs from the pre-treatment one are key questions to understand the effects of social integration of the urban poor. Our dataset allows us to estimate income and profession variation in the flux of new dwellers, as well as to build population composition metrics.

Strong evidence of gentrification When travel time to the city center decreases in treated QPVS, we expect central affluent urbanites to relocate in them, looking for larger dwellings or proximity to natural amenities (when applicable to the large, high rises housing compounds that often constitute the QPVs). We thus expect newcomers to exhibit higher skill profile and income than incumbents. By

[33] Census at the block level is only available in 2010 and 2015 at the date of publication

Figure 9: Prices and LRT arrival



Notes: this graph plot the $beta_k$ of equation 1; 95% confidence interval

Source: Perval

Diff. in diff. estimates	Housing Price (per m^2) (1)	(2)	(3)
LRT	0.063***		
	(0.015)		
< 1M hab		0.046	
		(0.030)	
> 1M hab		0.067***	
		(0.016)	
< 5Km CBD			0.069**
			(0.030)
> 5Km CBD			0.090***
			(0.024)
Obs.	18,220	18,220	10,713
Adj. R^2	0.752	0.752	0.722

Data : Perval   *p<0.1; **p<0.05; ***p<0.01

Figure 10: Market activity and LRT arrival

Notes: this graph plot the $beta_k$ of equation 2; 95% confidence interval

Source: FILOCOM

contrast, the characteristics of departing population is key to understand the overall effects of this new infrastructure. We turn to the household income at residence retrieved from our fiscal dataset that corresponds to effective dwellers. Figure 11 report the impacts of an LRT opening on income of current inhabitants and income of new dwellers. We find a significant effect on income of new dwellers, that increases of 600€(2.7%) after 6 years. New dwellers differ strongly from existing population. A similar, but slower increase is observed on mean household income of 500 €(2.2%) after 6 years. This figure is consistent with labor market effects being null or small, which imply that any massive change of income will be due to newcomers higher income and not unemployed incumbents finding a job. It is also consistent with increased turnover (around a yearly 6% which gives around 35% change of population at the end of the period). By means of comparison, Bardaka et al. (2018) found a 18,6% increase in the first 10 years in the low-income blocks treated by a LRT in Denver. However, the literature is not straightforward, since Dong (2017) found a mean decrease of - 4440$ (-12%) after 20 years, but no significant effect in the first 10 years in the neighborhoods connected to a LRT in Portland.

To complement this evidence, Figure C.2 in Appendix C report the probability that a buyer is an executive [34] and a seller an employee. We find significant evidence of an inflow of executives in neighborhoods previously considered as ranking among the poorest, and an increase in the departure rate of employees that might substantiate the claim of gentrification. However, these figures are not conclusive since we have no information that buyers and sellers in PERVAL would be, or not, the residents. Inflow of executive buyers may simply reflect rental investment in a neighborhood considered as a new opportunity.

Interpretation in terms of social integration The interpretation of these figures in terms of social equity is not straightforward. Indeed, population displacement does not constitute a direct evidence of worse social integration in deprived neighborhoods. On the contrary, since housing stock remains constant, any improvement of social diversity will come at the cost of departing incumbents. Social diversity will be improved if this replacement is limited, and will be degraded if replacement extends to the quasi-total displacement of previous population. To study social diversity impacts of our LRT openings in QPVs, we must compute a diversity index on the population of our neighborhoods of interest. The Theil (1967) index is an entropy-based measure of diversity on income in a population, defined by :

[34] Defined by aggregating all highly qualified categories in the french occupation category : namely senior civil servants, scientists and engineers, information and art producers, private sector executives, liberal professions

$$T = \frac{1}{N}\sum_{i=1}^{N}\frac{x_i}{\mu}\cdot\log(\frac{x_i}{\mu})$$

where $_i$ is each inhabitant's income and $\mu = \bar{x}_i$ the mean income.

The result of our staggered diff-in-diff regression, estimated on block-level computed Theil indices is reported in Figure 12. It exhibits a strong positive effect of the opening of an LRT on Theil diversity index, which means that diversity of income has increased in the first six years after connection. At this time-scale, the effects of gentrification on social diversity and therefore integration appear to be profitable for the remaining initial dwellers, that should still represent considering the estimated turnover an approximate 65% of the population. However, the stability of this result in the longer term, which we cannot examine with our data, is highly questionable. It is arguable that it may depend on forces counteracting gentrification, which can be (i) an increased capacity of incumbents to stay in the neighborhood, that may come from rising income due to an increased labor market integration, which we showed to be unlikely; (ii) an institutional setting that reduces the pressure of rising prices on the urban poor location choice.

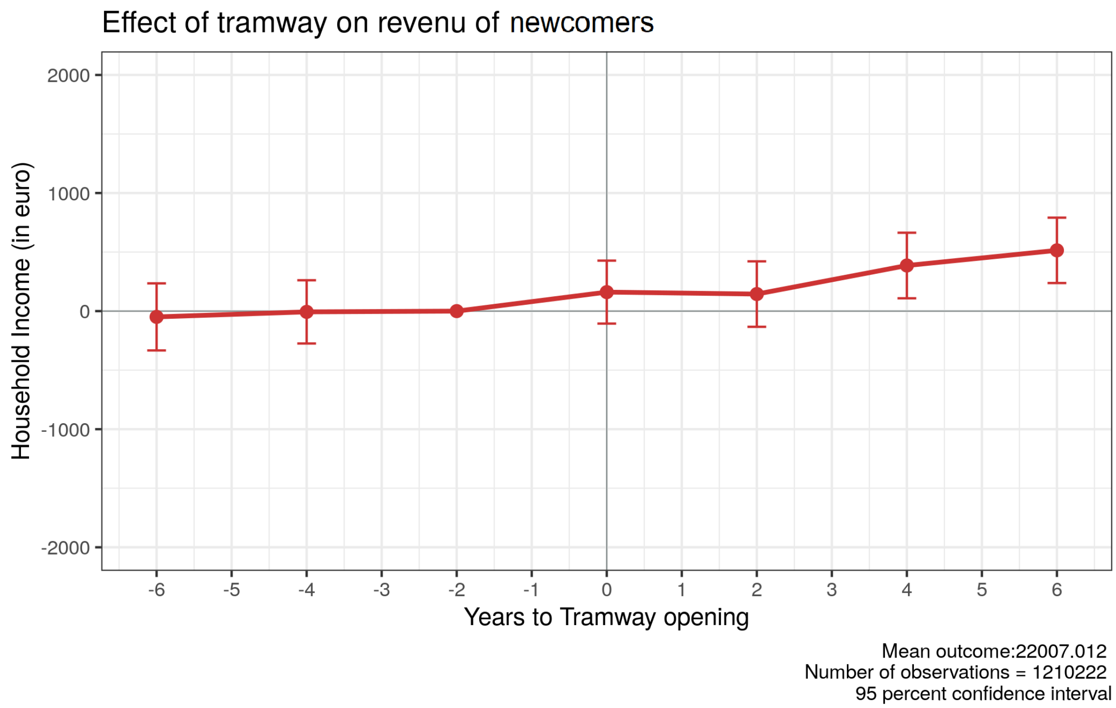
Actually, the long term impact of an LRT connection on social integration may heavily depend on occupation status of incumbents. For renters, an increase in rents consecutive to treatment would make a neighborhood less affordable and eventually induce migration out of the treated area, which would deprive them from the post-treatment accessibility gain. By contrast, owner-occupiers benefit, if they leave the treated zone, from the full value of the accessibility shock, capitalized into their dwelling's price[35]. By contrast, social housing tenants face no increase in rents, thus reducing pressure from migration, but do not benefit from leaving. We shall thus study the heterogeneous effects of an LRT stop opening alongside occupation status.

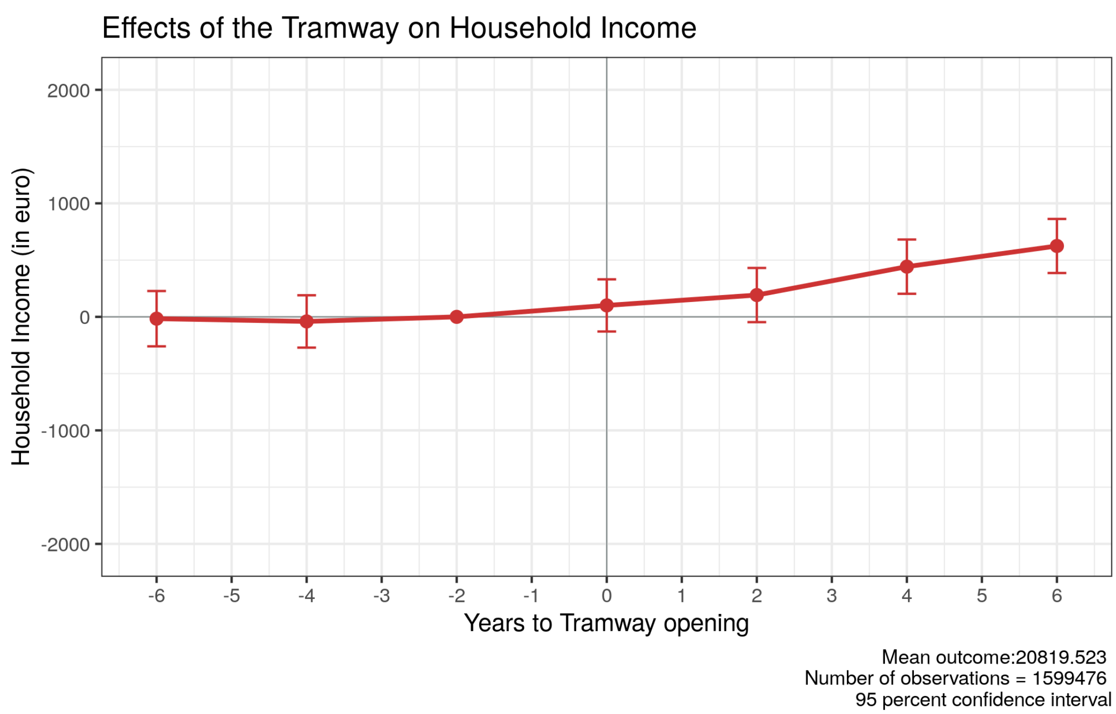
5.2.3 The ambiguous role of social housing in preserving social mixity

Using the diff-in-diff specification, we study the heterogeneity of previous graphical results along occupation status. We expect social housing tenants to be less volatile than private housing market participants, since social housing authorities have no incentive to raise rents or facilitate turnover. However, increased attractiveness of newly connected neighborhoods should increase quantity and

[35]Their mobility should be less influenced by housing prices, even though there is an opportunity value of living in one's own dwelling

Figure 11: Income of inhabitants / newcomers





Notes: this graph plot the $beta_k$ of equation 1; 95% Confidence interval

Source: FILOCOM

Table 8: Difference in Difference estimates

	Dependent variable:			
	Occupation Duration	Income (inhabitants)	Income (newcomers)	Income (departing)
	(1)	(2)	(3)	(4)
Owner-occupiers	-0.58***	524.2***	930.4***	891.3***
	(0.060)	(113.0)	(261.1)	(291.1)
Private housing tenants	-0.27***	714.2***	968.5***	897.3***
	(0.076)	(158.8)	(229.7)	(246.3)
Social housing tenants	-0.13*	205.8*	530.4**	291.3
	(0.058)	(111.2)	(220.8)	(238.9)
Observations	1190500	1190500	288436	268424
Adjusted R^2	0.15	0.21	0.21	0.17
F-stat	148.2	308.3	59.1	43.7

Data : FILOCOM & Perval   Note: *p<0.1; **p<0.05; ***p<0.01

Figure 12: Theil index (income) and LRT arrival

Notes: this graph plot the $beta_k$ of equation 2; 95% Confidence interval

Source: Perval

quality of the pool of applicants for social housing accommodation. We should thus expect a smaller but non-zero change in newcomers income in social housing.

Social housing as a support for social mixity Table 9 reports the effect of LRT on housing market variables by housing types. It appears that owner-occupiers are the most affected by the opening on an LRT stop. Their occupation duration decreases by 7,2 months, which constitutes a 33% drop. This spectacular decay may be linked to owner-occupiers willing to take advantage of their home's appreciation. Population changes are also quite spectacular, since mean income rises by 524.2 €, (2,3 %) and newcomers income by 930.4 (4,1%). More surprisingly, one cannot statistically reject equality between newcomers and departing owner-occupiers'income (the latter rises up to 891.3 €.). This may be interpreted as evidence that the market for owner-occupied dwellings has reached an equilibrium six years after the opening of an LRT. Private rental market appear as attractive for newcomers as the owner-occupiers one, with very similar increase in newcomer and departing income (actually the point estimates are even a bit higher, at 968.5 €for newcomers). However, private housing tenants seem well protected from increased demand and rising rents by their tenancy[36], which must explains their low drop in occupation duration (half the mean effect).

As for social tenants, their status protected them from the changes of the private housing market. The drop in occupation duration is hardly significant and we do not observe changes in the income of departing population. Everything happens as if incumbents willing to stay in the newly connected neighborhood could do so. Newcomers, by contrast, are a bit wealthier after connection to the LRT, as competition among applicants may have increased.

Social housing thus exhibits a protective function that preserve its tenants from the adverse displacement effects of gentrification. Social tenants appear as the true beneficiaries of the new infrastructure : they benefit both from its accessibility effect, that has a positive welfare impact on their travel time, even if it does not facilitate job matching, and from increased social mixity. By contrast, results on the private market indicate that, in absence of social housing, gentrification and population displacement would capture an important -but still to be determined- part of welfare gains from an infrastructure targeting the most deprived areas. These effects, that we have only been able to study in short term, may even wash out, if gentrification is complete, any benefit from the infrastructure for the poor primary inhabitants. Could a combination of social equity concerns in the design of transport

[36]Tenancy Law is quite protective for tenants in France, since rents cannot be revised for the tenancy duration more than a national inflation rate, and terminating the rental agreement takes time.

networks and increased social housing therefore be effective in reducing spatial inequalities ?

Social housing as a obstacle for social mixity Catchy though it appears, this narrative must be tempered down by taking into account general equilibrium effects of an increase in social housing presence. An increase in social housing share in the housing stock may have adverse effects on surrounding housing market: (i) it may come at the cost of some 'redlining', since social housing concentrate the urban poor, and sometimes ethnic minorities that can be discriminated against. In that case, the mean income of surrounding inhabitants is not likely to increase with an LRT connection, and may even decrease as low-income households that value more public transport (Glaeser et al., 2008) may migrate to a well connected neighborhood that does not experience gentrification ; (ii) even without any discrimination, a large share of social housing in the housing stock could affect the surrounding market by reducing the pool of dwellings up to rental or sale, discouraging research in the area. However, with this mechanism, turnover may be slower but prices may rise eventually after an LRT connection.

Table 9 reports the result of a diff-in-diff specification on household income and housing price for neighborhoods above and below the national median of QPVs social housing shares. There is evidence that would support the first mechanism, since we find no significant impact on income in neighborhoods over the national median (the point estimate is even negative) concomitantly with a positive effect on prices (7% elasticity, in line with the price capitalization observed in neighborhoods under the national median).

To complement this result, Figure C.3 and Figure C.2 in Appendix C report the probability a buyer in a QPV is an executive, and the seller an employee . We find no significant effect in QPVs intensive in social housing, by contrast to QPVs intensive in private housing for which the estimates are in line with the mean case exposed in Figure C.2 (higher proportion of executives among buyers). This behaviour constitutes another evidence of 'redlining' for the social housing intensive QPVs.

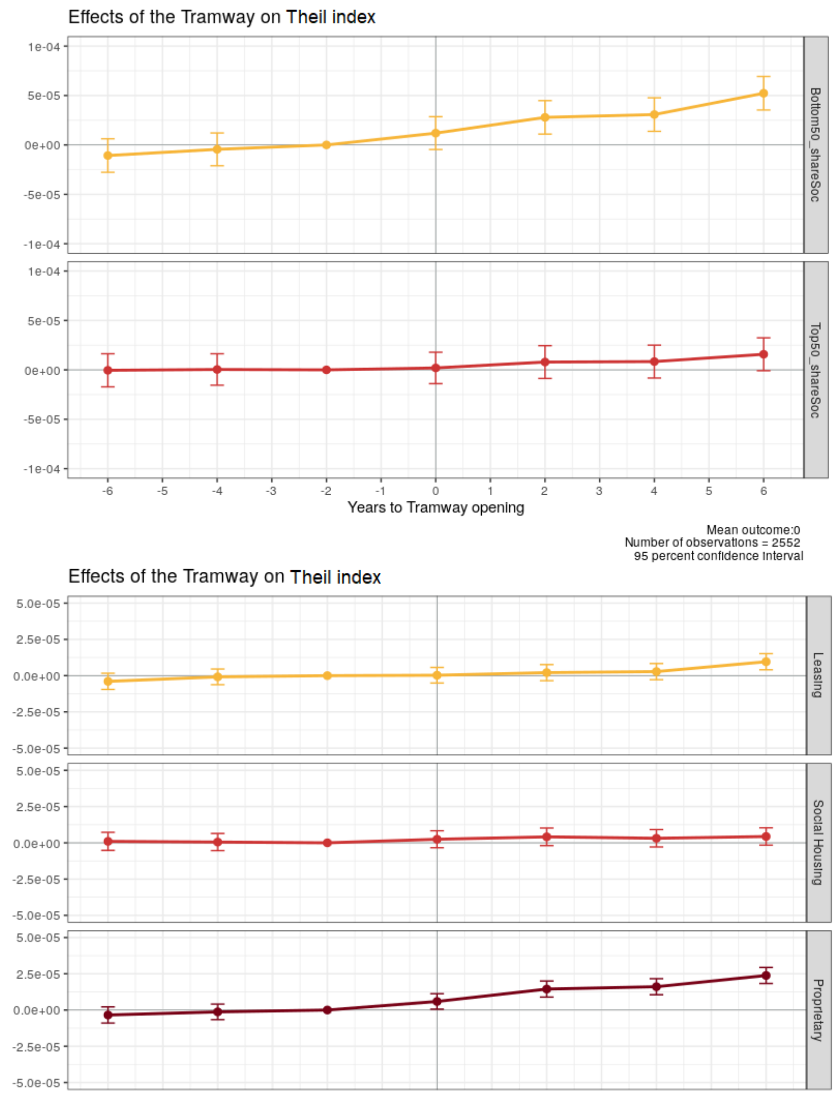
Such 'redlining' has two opposite effects : on the one hand, it reduces the capture of the welfare gains from increased accessibility by affluent urbanites, on the other hand, it does not increase social diversity, whose peer effects could prove necessary to improve durably the situation of the urban poor, peculiarly in a context where they face many obstacles on the job market. Figure 13 reports the increase in the Theil index between low and high social housing intensity neighborhoods.

Table 9: Difference in Difference estimates

	Dependent variable:			
	Household Income		Housing Price (in log)	
	(1)	(3)	(5)	(7)
LRT	441.7***	-	0.063***	-
	(74.8)		(0.015)	
< Med. Soc. Hous.	-	976***	-	0.064***
		(119.1)		(0.020)
> Med. Soc. Hous.	-	−72.6	-	0.072***
		(105.8)		(0.021)
Obs.	1,191,558	1,126,463	18,220	17,590
R^2	0.091	0.094	0.756	0.757

Note: PERVAL & FILOCOM (2006-2014) *p<0.1; **p<0.05; ***p<0.01

Figure 13: Theil by social housing share and occupation status



Notes: $beta_k$ of equation 1; 95% Confidence interval Source: Perval

We find no impact of a LRT stop opening on social diversity in social housing intensive QPVs, while the impact is strong and significant in private housing intensive ones. The second graph of Figure 13 shows that this effect is largely driven by owner-occupying newcomers, who concentrate the major part of total social diversity, and appear to be pecularly rare in social housing intensive QPVs. Social housing thus appears as an ambiguous tool, that may participate to increase social isolation even in a context of public transit connection. In terms of policy recommendations, a public transit infrastructure deviating from the utilitarian decision criteria to remedy urban inequalities could thus have chances to be effective only if accompanied by a constant but moderate social housing construction policy.

6 Conclusion

This paper takes advantage of the construction of LRT networks in most French city in the last 30 years to document the effect of a public transportation infrastructure aiming at connecting the most deprived neighborhoods on those area and their inhabitants. We rely on three administrative data bases with granular geographic precision to compare the evolution of unemployed, housing transactions and housing compositions around the arrival of LRT. To do so, We estimate a staggered difference in difference comparing linked neighborhood with similar neighborhoods in the same city.

The first part of our work focuses on the short term effect of LRT on labor outcomes of the job seekers. We do not find any change in unemployment trajectories between job seekers living in treated and control neighborhoods. This results is consistent for multiple relevant heterogeneity groups and ultimately estimated with great precision living no room for an economically significant effect. This results is particularly interesting through the lens of the spatial mismatch literature, while focusing on a population for which spatial mismatch ought to be particularly acute, we find no reduction of adverse labor trajectories. In fact, inhabitants of the poorest neighborhood face many hurdle in the labor market. If increased accessibility could well be necessary to improve their labor trajectories, our results suggest that it is certainly not sufficient.

The second part of the article provides evidences of change in housing price and population composition. It first highlight the amplitude of the accessibility shock brought by a new tramway infrastructure connected deprived neighborhoods. This shock capitalizes in a large local increase of housing prices in connected QPVs. A focus on population evolution after LRT connection allows to get more insights on the beneficiaries of this accessibility shock. Housing market adjustments often result in partial displacement of initial poor tenants following the rent increase, who do not benefit from the infrastructure. Owner-occupiers, by contrast, often migrate but benefit of the accessibility shock through capitalization in their dwelling's price. Social tenants have no incentive to migrate and can benefit from both the accessibility improvement and the peer effects induced by large social diversity. However, this mechanism does not take place in social-housing intensive QPVs, where we observe no in-migration of affluent urbanites.

Taken together, our results underline that even if LRT construction do not translate into better labor outcomes, the gained accessibility *per se* is beneficial to deprived neighborhoods residents if they are not too sensible to housing market adjustments. For policy makers looking forward to integrating social fairness criteria in the design of public transportation, this paper shows that no benefit for the urban poor can be expected in the short term on the labour market, and that their benefits on the housing market are incertain and mainly depend on the coupling of such a "social" transportation policy with a comprehensive social housing policy, the amplitude of which depend mostly on the value granted to social diversity, since high density of social housing appears as a cause of 'redlining'.

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A French Tramways

A.1 A brief history of Tramways

Electric tramways, alongside heavy suburban steam engine trains, played an important role of connecting poor workers to jobs in modern metropolis (Heblich, Stephan and Redding, Stephen J. and Sturm, Daniel M., 2020). This transportation mode have been indeed very popular in early 20th century France, where more than 130 cities were equipped, as well as in most Western countries. However, its development was severed in the late 30's by the competition of internal combustion vehicles and almost totally disappeared after World War II due to the combination of low fuel prices, rise of individual car and a correlated shift of public investment to road construction (Goddard, 1996). In the United States, streetcars totally disappeared from the urban landscape. In France, only 3 networks out of 130 remained operational in 1975. The exception of Germany and Northern Europe, were most networks remained in activity, is partly explained by the high densities in Rhine valley cities, low electricity price nearby coalmines and local institutional settings that favoured decentralized decision-making. Countries of the Eastern block also kept their pre-war networks, notably because of the low development of individual vehicles. The resulting disconnection between centers and peripheries was a growing concern for mayors in the end of the 20th century. France pioneered a new "glorious era" for LRT in the mid-1980's. Yet in 1975, a national scheme, the "Cavaillé Plan" financially encouraged eight major cities to build a LRT to solve congestion issues induced by the rapid extension of peripheral neighborhoods. It was thought that LRT was the best compromise for medium size French cities, since it can carry 5 times the flow a bus system can, for a cost limited to 3 times the one of buses, and only one fifth of the cost of a metro line. After half a century of decline, French tramway renewal has pioneered a renewed popularity of light rail transit (LRT, or streetcars) among urban planners during the last two decades both in developed and developing countries. In a context of growing metropolisation, LRT, cheaper, quicker to build and more versatile than heavy rail infrastructure, is expected to facilitate commuting to jobs, tamper spatial disparities and reduce carbon emissions in rapidly growing cities worldwide. In North Africa, 9 cities have been building a LRT network since 2000, alongside with 11 in the Middle East, 4 in China and many ongoing projects. However, none of these LRT construction programs have been larger and more consistent that the French one. Moreover, the French case often serve as an explicit reference case for these works.

A.2 Descriptive statistics

Figure A.1: Public transportation Montly pricing

	Normal Monthly Fare	Lowest Social Monthly Fare
Angers	43,50 €	21,00 €
Besancon	43,50 €	2,00 €
Bordeaux	50,00 €	- €
Brest	38,50 €	6,20 €
Caen	41,00 €	- €
Clermont Ferrand	52,20 €	9,10 €
Dijon	42,00 €	- €
Grenoble	60,00 €	2,50 €
Le havre	43,00 €	12,50 €
Lemans	41,00 €	3,80 €
Lyon	65,00 €	10,00 €
Marseille	50,00 €	- €
Montepllier	53,50 €	3,00 €
Mulhouse	43,00 €	17,00 €
Nantes	69,00 €	- €
Nice	45,00 €	20,00 €
Orleans	43,60 €	10,10 €
Paris	75,00 €	18,00 €
Reims	38,55 €	unknown
StEtienne	47,00 €	3,73 €
Strasbourg	51,80 €	5,80 €
Toulouse	50,00 €	- €
Tours	45,00 €	10,00 €
Valenciennes	38,50 €	13,20 €
Average	48,96 €	6,68 €

Priced are as publicised on the internet website of the local transport agency in septembre 2019. Price includes access to the local public transport network for a month. Several social monthly fare exists and depend on the household revenue. A welfare recipient would be entitled to the lowest social fare.

Figure A.2: Number of tram stops by year in the last two decades in France

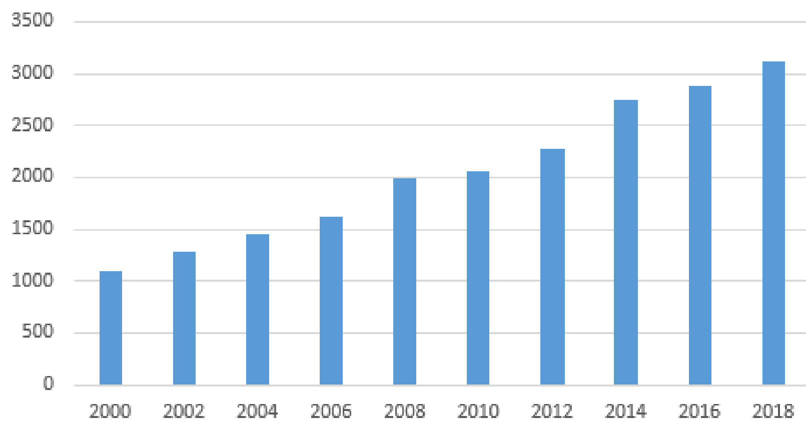


Figure A.3: Number of tram stops by year in the last two decades in France

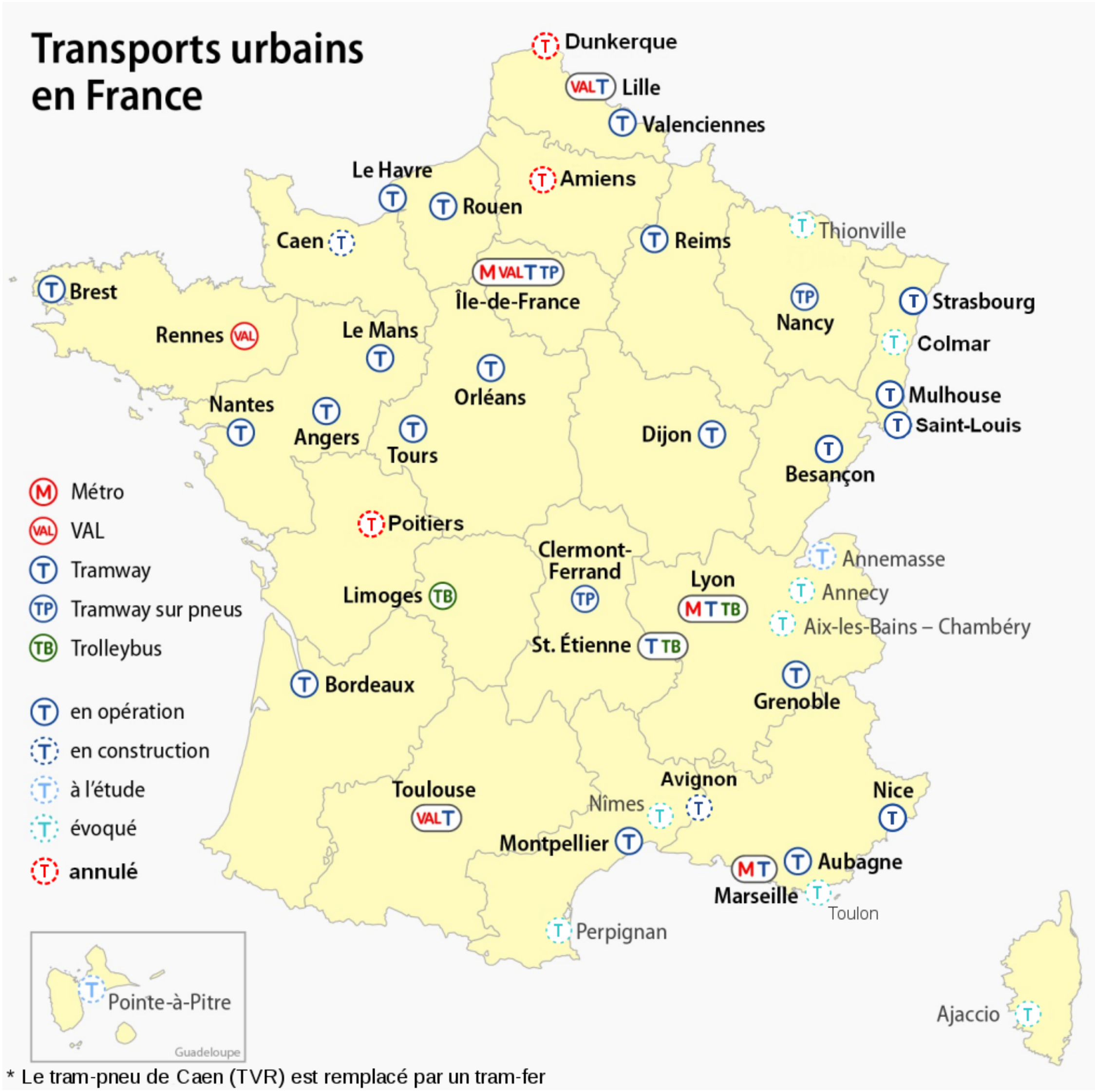
Fiscal data

Price data

Labor data

City	Opening Date	Length (km)
Saint-Étienne	04/12/1881	11,7
Lille - Roubaix - Tourcoing	04/12/1909	17,5
Nantes 1	07/01/1985	17,6
Grenoble A	05/09/1987	12,7
Grenoble B	26/11/1990	10,5
Paris 1	06/07/1992	17
Nantes 2	26/09/1992	11,7
Strasbourg A	25/11/1994	14,65
Strasbourg B	26/11/1994	14,8
Strasbourg C	27/11/1994	8,1
Rouen	17/12/1994	15,1
Strasbourg D	20/06/1995	12,5
Paris 2	01/01/1997	17,9
Nantes 3	27/09/1998	14,1
Montpellier 1	30/06/2000	15,7
Orléans A	24/11/2000	18
Orléans B	24/11/2000	11,3
Nancy	08/12/2000	11,1
Lyon T1	02/01/2001	11,7
Lyon T2	02/01/2001	14,9
Lyon T3	02/01/2001	14,6
Bordeaux A	21/12/2003	24,2
Bordeaux C	24/04/2004	20,8
Bordeaux B	15/05/2004	19,5
Paris 3	01/01/2006	26,7
Paris 4	01/01/2006	7,9
Mulhouse 1	20/05/2006	16,2
Mulhouse 2	20/05/2006	5,8
Grenoble C	21/06/2006	9,4
Valenciennes T1	03/07/2006	18,3
Clermont-Ferrand	16/12/2006	15,7
Montpellier 3	16/12/2006	17,5
Strasbourg E	01/01/2007	11,85
Marseille T1	30/06/2007	5,4
Marseille T2	30/06/2007	6,5
Grenoble D	06/10/2007	2,6
Le Mans T1	17/11/2007	9
Le Mans T2	17/11/2007	9
Nice	24/11/2007	16,2
Lyon T4	21/04/2009	16
Lyon T6	09/09/2010	22
Toulouse	11/12/2010	16,7
Mulhouse 3	12/12/2010	6,2
Reims 1	16/04/2011	9,05
Reims 2	16/04/2011	10
Angers	25/06/2011	12,3
Montpellier 3	07/04/2012	23
Montpellier 4	07/04/2012	9,2
Brest	23/06/2012	14,3
Dijon T1	01/09/2012	8,5
Lyon T5	17/11/2012	3,8
Paris 5	01/01/2013	6,6
Paris 7	01/01/2013	11,2
Paris 6	01/01/2014	14
Paris 8	01/01/2014	8,5
Dijon T2	01/12/2012	11,5
Le Havre A	12/12/2012	8,35
Le Havre B	12/12/2012	8,95
Tours	31/08/2013	15,5
Valenciennes T2	24/02/2014	15,5
Grenoble E	29/05/2014	11,5
Besançon T1	30/08/2014	13,4
Besançon T2	31/08/2014	9,6
Marseille T3	30/06/2015	3,6
Paris 9	01/01/2017	11
TOTAL		625,5

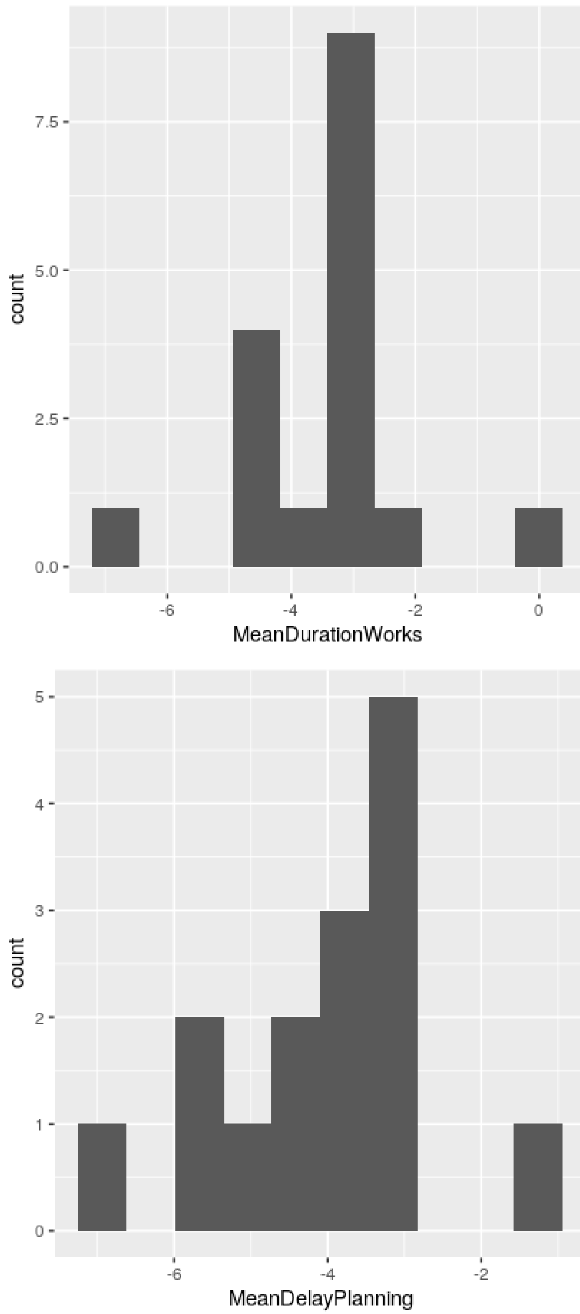
Figure A.4: Number of tram stops by year in the last two decades in France



A.3 The French public transport infrastructrure decision process

The mean delay between the publication of the chosen route and the line opening is 3,48 years. The delay between public debate and line opening is more volatile, however the mean project being completed 4 years after public debate. Histograms A.5 show the distribution of these delays among projects.

Figure A.5: Mean duration of works and mean delay after public debate



B Unemployment analysis

B.1 Geocoding procedure for unemployed's addresses

Using a phonetic fuzzy string matching algorithm and the French database of Postal Addresses BAN provided by French Postal Service, we are able to associate up to 85% of spells with the coordinates of the job seeker's residence, through the geocoding of 41,579,075 addresses.

Data and methods The *Base d'Adresses Nationale* (BAN)[37] is the French national postal service addresses database. It offers a set of spatial coordinates with a metric precision for each location in the French territory whose address if specified according to the rules of the postal service, which notably implies a correct spelling of name of the road, the municipality and its postal code. It contains 24.6 million addresses and 200 000 rural localities.

We resort to this database to geocode the job seekers addresses exerted from the *Fichier Historique* database. However, we face an important issue since information entered in the administrative forms by job seekers are usually not structured according to the rules of the postal service, and even often not correctly spelled. We thus need a phonetic correspondence matching algorithm to be able to geocode a significant fraction of our job seekers. Table 1 exhibits some fuzzy matching challenges one has to deal with when locating job seekers from these addresses.

Table 1: Random sample of *Fichier Historique* addresses and their correspondance in the BAN

Address entered by job seeker	**Address structured by the rules of the Postal Service**
N RTE REYRIEUX, 01600	N Route de Reyrieux, 01600 Trévoux
RESIDENCE LE FONTAINE, CHEM DES MAGNY, 01280	Nf Chemin de Magny, 01280 Prévessin-Moens
CHEZ MR Y, 01450	N/A
LA BOURDONNIERE, RTE DE BOURG EN BRESSE, 01320	N Route de Bourg, 01320 Chalamond
RUE BEL FERME, 01170	La Belle Ferme, 01170 Gex
HAM L AMICOLIERE 01270	Hameau La Nicolière 01270 Beaupont
N R MAL DELATTRE DE TAS 01100	N Rue du Maréchal de Lattre de Tassigny, 01100 Oyonnax
FONDATION ANTONIOZ, RTE DE GENEVE 01120	Avenue de Genève, 01120 Divonne les Bains
CHEZ MR X, N R ANTOINE DE SAINT EXUPERY 01160	N Rue Saint-Exupéry, 01160 Pont d'Ain
N RUE DU DR MONTREAL LA CLUZES	N Rue du Docteur Rossand, 01460 Montréal la Cluzes

Notes: Random sample of addresses from the *Ain* département and result from fuzzy matching with the BAN. Names of eventual hosts have been anonymized for privacy reasons.

[37] Publicly available on the governmental website https://adresse.data.gouv.fr/

Fuzzy string matching algorithm exist in currently used statistical programs, however, to the best of our knowledge, none of thee is able to compute a phonetic correspondence based on French language. This issue is particularly important since French phonetics may be particularly ambiguous. We thus turned to an open source matching engine named *Addok*, specifically designed to deal with french addresses, developed by the government Open Data Office (*Etalab*). An API is available on the government website, however, due to the heavy volume of data (41,579,075 addresses) we have to deal with, we preferred a local implementation of the algorithm, using the code available on GitHub[38]. We then cross validated a sample of our results with the google maps API.

Practically, we run the Addok engine over the BAN on a 40 Go RAM local machine, while a Python routine interrogates both the Addok engine and the Google Maps API, if necessary.[39] The complete review of the 41 million addresses takes 4 days.

Considering that many job seekers do not correctly specify their addresses (typically, they may enter the name of the person that is hosting them, instead of their address), we are in the end able to we are able to associate up to 85% of spells with the coordinates of the job seeker's residence.

[38]See https://github.com/cquest/geocodage-spd/

[39]Code available upon request. Provided we do not have a paid key to access the Google Maps API, we are limited in terms of daily requests, and chose only to submit to the Google API the addresses whose score with the Addok engine was low. On subsample tests, we observe that the Google API is less precise than the Addok engine in the general case, but performs very well to localize isolated or rural localities that do not appear in the BAN.

B.2 Descriptive statistics

Table 2: Summary Statistics - Population Mean (standard deviation) before LWT arrival

group	Treated	Never Treated	General population
Disable worker	0.05 (0.22)	0.05 (0.22)	0.04 (0.2)
Indemnisation_Indemnisation	0.36 (0.48)	0.39 (0.49)	0.4 (0.49)
Single	0.61 (0.49)	0.6 (0.49)	0.63 (0.48)
Married	0.31 (0.46)	0.32 (0.47)	0.3 (0.46)
EmploiRech_CDD Temps Complet	0.03 (0.16)	0.02 (0.15)	0.03 (0.18)
EmploiRech_CDI Temps Complet	0.81 (0.39)	0.82 (0.38)	0.81 (0.39)
EmploiRech_Contrat Saisonier	0.05 (0.21)	0.04 (0.2)	0.05 (0.22)
Agriculture and Fishing	0.02 (0.14)	0.02 (0.15)	0.02 (0.13)
Art and Shaping Art works	0.01 (0.07)	0.01 (0.08)	0.01 (0.09)
Banking, Insurance, Real Estate	0 (0)	0 (0)	0 (0)
Trade Sale and Large distribution	0.16 (0.37)	0.16 (0.37)	0.16 (0.37)
Communication and media	0.01 (0.11)	0.01 (0.1)	0.02 (0.16)
Construction Building and Public Works	0.1 (0.3)	0.09 (0.29)	0.07 (0.26)
Restauration Tourism and Leisure	0.07 (0.26)	0.07 (0.25)	0.08 (0.26)
Industry	0.08 (0.27)	0.08 (0.26)	0.07 (0.25)
Installation and Maintenace	0.03 (0.18)	0.04 (0.2)	0.03 (0.17)
Health	0.02 (0.13)	0.02 (0.14)	0.02 (0.15)
Personal Community Services	0.21 (0.41)	0.22 (0.41)	0.21 (0.4)
Show	0.01 (0.1)	0.01 (0.09)	0.02 (0.14)
Support to the Company	0.09 (0.29)	0.1 (0.3)	0.14 (0.34)
Transport and Logistic	0.09 (0.29)	0.1 (0.3)	0.07 (0.25)
Unkown	0.08 (0.28)	0.08 (0.27)	0.09 (0.28)
Population	16176	7288	123161

Notes : Statistics from jobseekers registering in their local agency in the second quarter of 2005
Housing variables and Joblessness Survival are block level mean weighted by the number
of unemployed living in the blocks in each group

B.3 Heterogenity Analysis

Figure B.1: Heterogenity results by cities

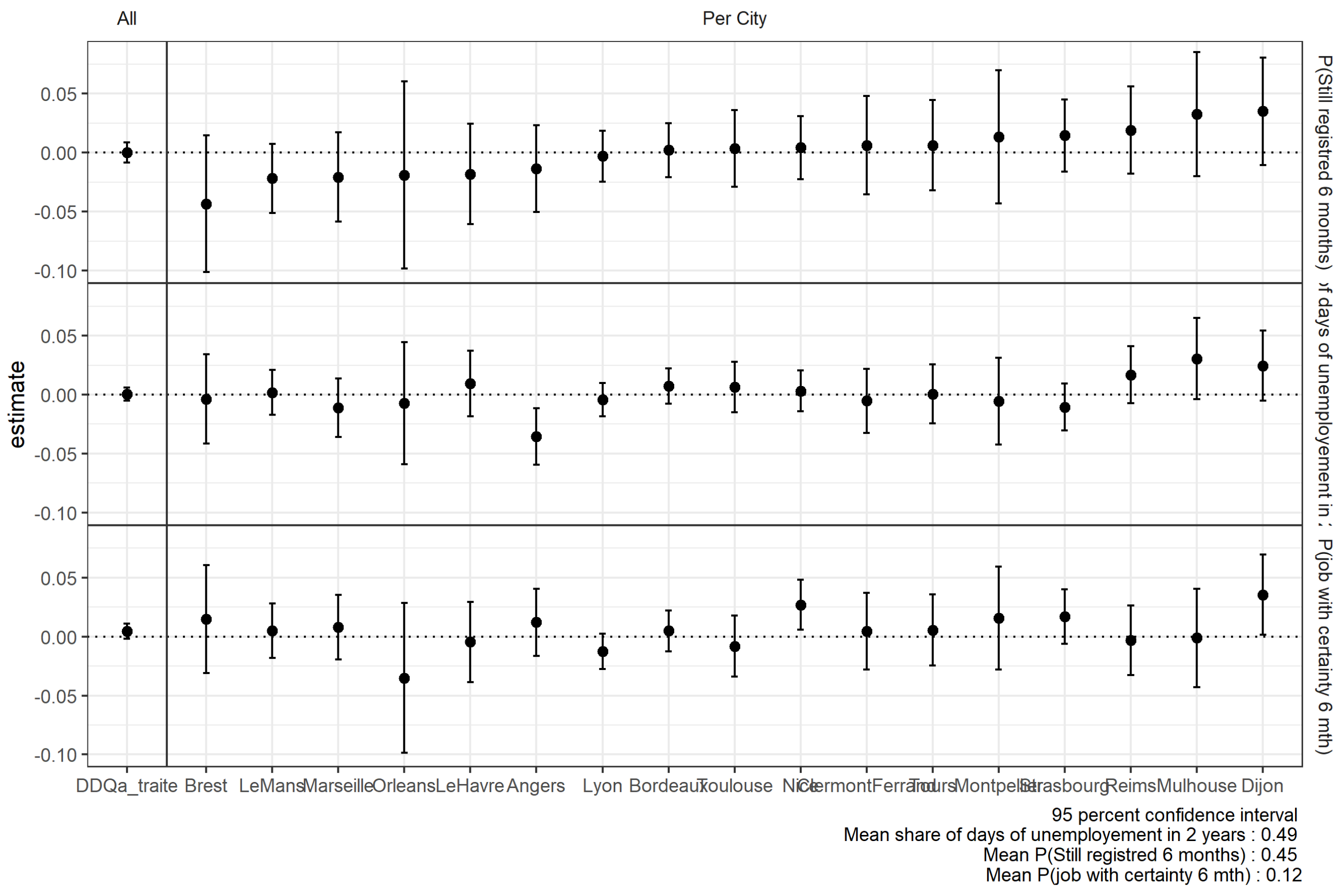
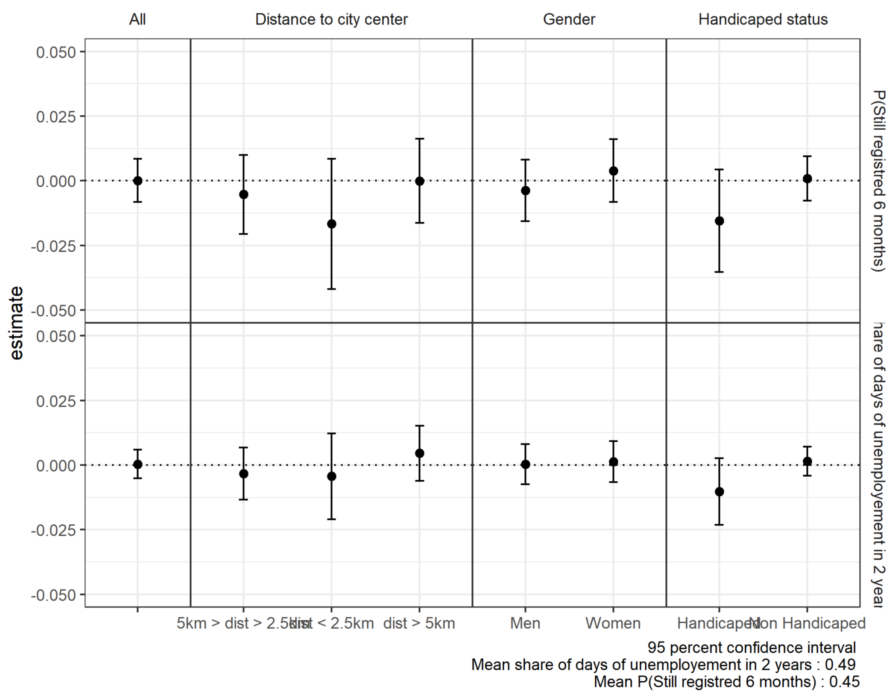


Figure B.2: Heterogenity Analysis



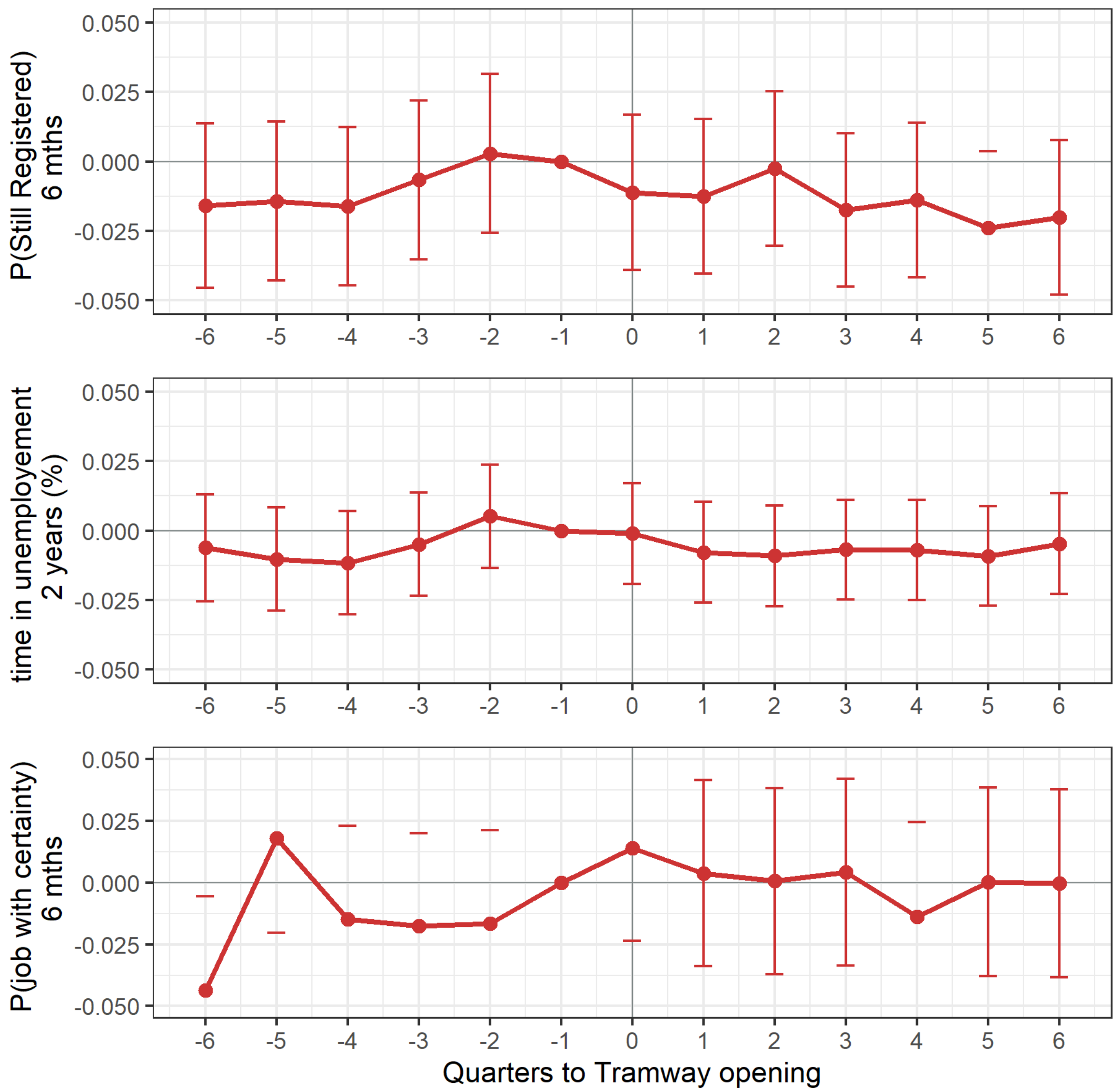
B.4 Results on Common Openings

Table 3: Difference in Difference estimates

	Dependent variable:		
	P(Still registred 6 months)	Number of spells 1 year	P(job with certainty 6 mth)
	(1)	(2)	(3)
LWT	−0.003	−0.002	0.010
	(0.007)	(0.005)	(0.006)
Minimum Detectable Effect	0.018	0.011	0.015
Mean Outcome	0.41	0.45	0.135
Observations	92,378	92,378	2,390
R^2	0.159	0.160	0.412
Adjusted R^2	0.155	0.156	0.299
Residual Std. Error	0.452 (df = 91936)	0.289 (df = 91936)	0.403 (df = 2004)

Note: *p<0.1; **p<0.05; ***p<0.01

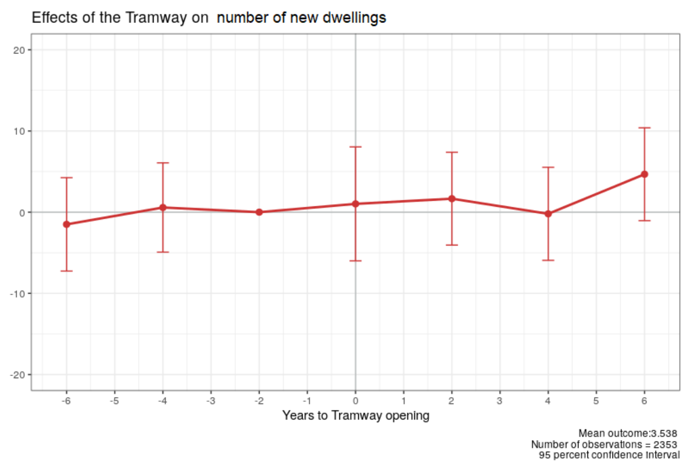
statistical significance a = 0.05; statistical power (1 <U+0392>) = 80 percent


P(Still Registered)
6 mths
time in unemployement
2 years (%)
P(job with certainty)
6 mths
0.050
0.025
0.000
-0.025
-0.050
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Quarters to Tramway opening

C Housing market

C.1 Housing stock

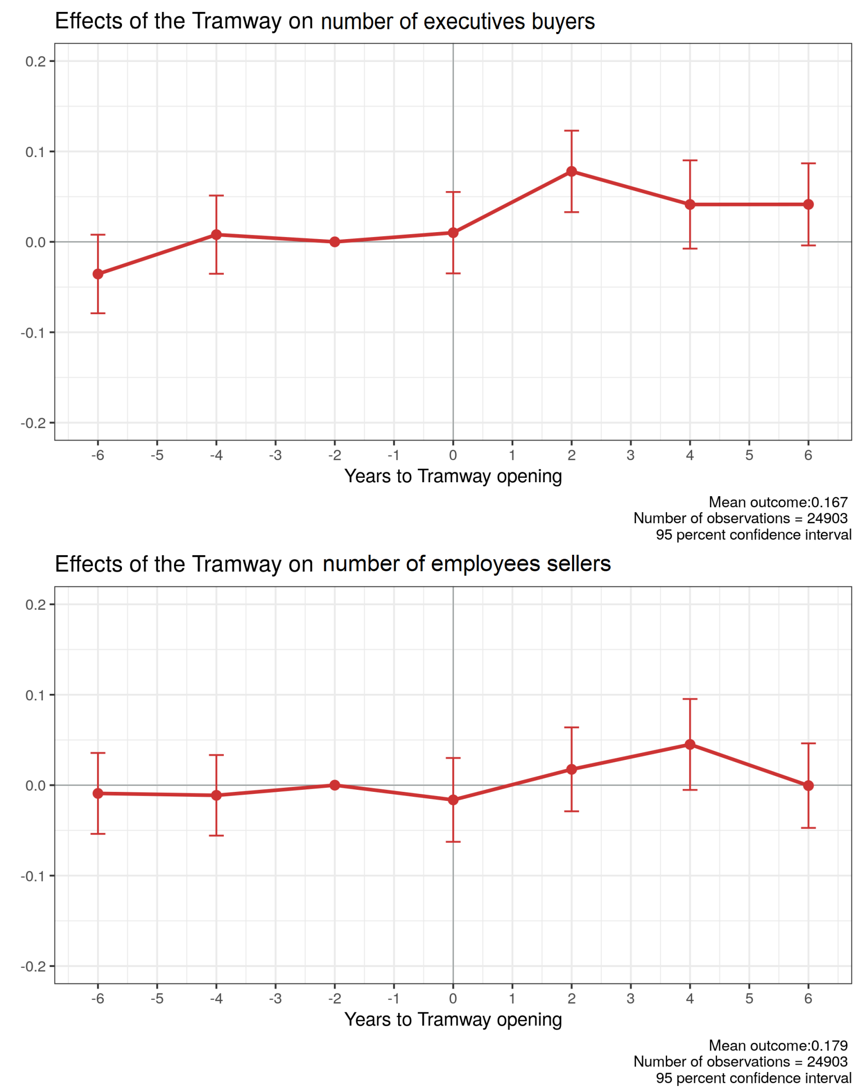
Figure C.1: Number of new dwellings and LRT arrival



Notes: plot the $beta_k$ of equation 1; 95% Confidence interval Source: Perval

C.2 Occupation of buyers and sellers

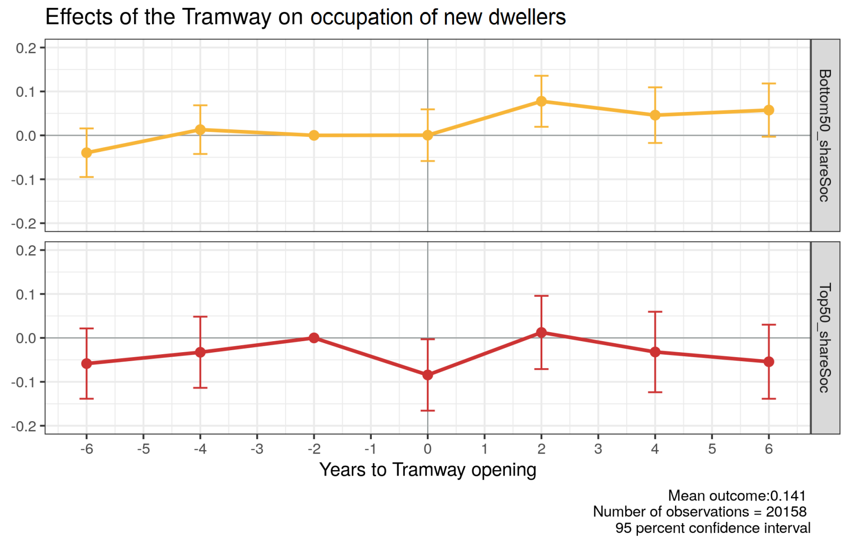
Figure C.2: Occupation of inflow/outflow urbanites



Notes: this graph plot the $beta_k$ of equation 1; 95% Confidence interval

Source: Perval

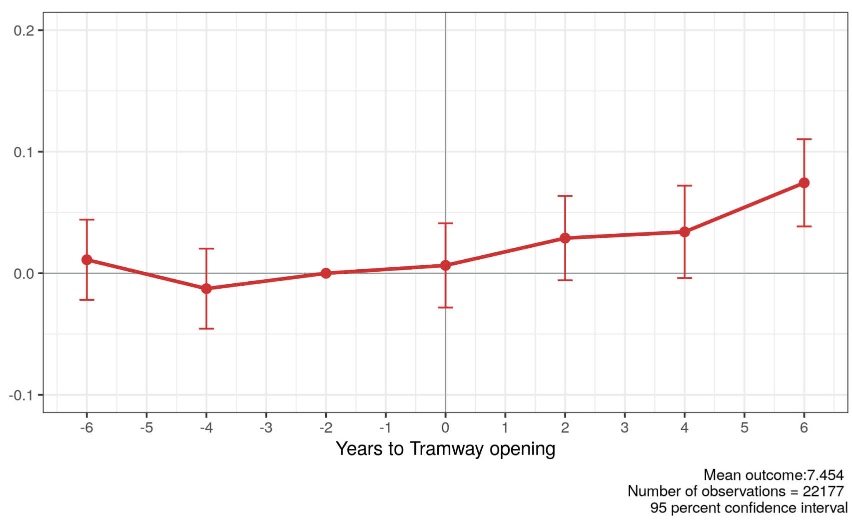
Figure C.3: Profession and LRT arrival



Notes: $beta_k$ of equation 1; 95% Confidence interval Source: Perval

C.3 Robustness checks on housing market

Figure C.4: Prices and LRT arrival without new buildings



Notes: this graph plot the $beta_k$ of equation 1; 95% confidence interval

Source: Perval

Figure C.5: Market activity and LRT arrival without new buildings

Notes: this graph plot the $beta_k$ of equation 1; 95% confidence interval

Source: FILOCOM

C.4 Heterogeneity

Figure C.6: Housing Prices and LRT arrival by city size (different bunchs)