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Local Public Policies and Spatial Income Inequalities

Morgan Ubeda

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THÈSE DE DOCTORAT EN SCIENCES ECONOMIQUES

Présentée en vue de l'obtention du grade de docteur de l'Université de Lyon,

délivré par l'Université Lumière Lyon 2

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Résumé de la thèse

Les inégalités entre territoires minent la cohésion sociale et influencent les trajectoires individuelles. La littérature sur les effets de voisinage a montré que la concentration de la pauvreté dans les territoires enclavés affecte négativement les opportunités d'emploi, les résultats scolaires et la santé des habitants de ces quartiers. De plus, les inégalités d'accès aux infrastructures publiques viennent accentuer les inégalités économiques. En France par exemple, 72% du territoire national (27% de la population) ne sont pas couverts par une autorité organisatrice de la mobilité et ne bénéficient pas de réseau de transport local, tandis que 14% seulement des communes sont à moins de trois kilomètres d'une gare ayant plus de six trains par jours ([Union des Transports Publics et ferroviaires, 2019](#); [Gaudremeau, 2014](#)). Ces inégalités d'accès aux services publics exacerbent les tensions entre centres et périphéries, et participent à détruire la cohésion nationale, comme en attestent le récent épisode de contestation des Gilets Jaunes.

Cette thèse propose, en trois articles, une contribution à notre compréhension des liens entre politiques publiques, organisation du territoire et inégalités spatiales.

Le premier chapitre étudie les effets des politiques de transport urbain sur les inégalités de revenus dans les aires urbaines. Plus précisément, il offre un modèle d'équilibre spatial d'une aire urbaine qui permet de modéliser les choix

de localisation résidentielle et de lieu de travail des salariés, tout en prenant en compte les ajustements du marché du logement, des salaires et des aménités locales. Le modèle est ensuite calibré sur l'aire urbaine de Paris, et employé pour simuler l'effet de deux politiques de transport sur les inégalités de revenus: a) le réseau RER et b) une hypothétique interdiction de l'utilisation de véhicules personnels dans Paris intra-muros. Les exercices de simulation révèlent qu'en plus de réduire les inégalités en termes de bien-être et de favoriser la péri-urbanisation, le réseau RER a permis de résoudre les inégalités entre communes de la région, et a fortiori entre Paris et sa périphérie. En ce qui concerne les restrictions d'usage des véhicules personnels, le modèle prédit une réduction des inégalités entre Paris et la périphérie, au prix d'une importante perte de bien-être social.

Les second et troisième chapitres analysent les effets de la coopération intercommunale, mutation institutionnelle majeure des vingt dernières années.

Devant l'accélération des réformes territoriales observées dans plusieurs pays décentralisés, le second chapitre propose une analyse des phénomènes de regroupement – fusion ou coopération – observés au niveau des collectivités locales. Après avoir dressé un rapide panorama des diverses formes institutionnelles de consolidation budgétaire avec un éclairage particulier sur le cas français, nous présentons les fondements théoriques de ces mouvements de réorganisation territoriale ainsi que les facteurs qui contribuent à la formation de ces nouvelles entités locales. Nous synthétisons ensuite la littérature empirique sur les effets des fusions ou des coopérations entre collectivités locales sur les variables économiques telles que la croissance, les dépenses publiques et la fiscalité dans différents pays. Nous présentons enfin une analyse originale des effets de l'intercommunalité sur les revenus et la localisation des ménages en France.

Finalement, le troisième chapitre revient sur les effets de l'intercommunalité sur l'offre de services publics locaux. La coopération intercommunale était en

effet supposée augmenter l'efficacité de l'offre de services publics en exploitant des économies d'échelles, tout en remédiant à la potentielle sous-optimalité des taux de taxes due aux effets de débordement et aux phénomènes de concurrence fiscale. À l'aide d'une estimation en double différences qui exploite l'échelonnement dans le temps de l'adoption de l'intercommunalité en France, ce troisième chapitre estime l'effet de la coopération sur le budget des communes. Les résultats économétriques montrent une augmentation conséquente des dépenses totales du bloc communal, qui ne semble pas être tiré par les dépenses de personnel. En exploitant les comptes par fonction des collectivités, nous montrons ensuite que cette hausse des dépenses provient intégralement d'une augmentation des dépenses d'urbanisme et des dépenses générales. Finalement, en étudiant l'effet de transferts de compétences conditionnellement au fait de coopérer, nous trouvons qu'un quart de l'effet de la coopération sur les dépenses peut s'expliquer par le transfert de trois compétences : les transports en commun, l'action économique et la collecte des ordures ménagères. Au final, ces résultats montrent que l'augmentation de la dépense due à l'intercommunalité a été, au moins en partie, le fait d'une augmentation de l'offre de certains biens publics que les communes, de par leur petite taille, ne pouvaient pas offrir isolément.

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Introduction

Territories are unequal. Even in the richest nations, some communities thrive and benefit from a wealth of opportunities, services and amenities, while some others are left behind, without access to jobs, infrastructure or services.

These spatial inequalities can be one of the factors perpetuating social inequalities and conflict. Within cities, a large literature on neighborhood effects and social interactions points to the concentration of poverty in urban areas as detrimental to the achievements of the inhabitants of these enclaves (Durlauf, 2004; Gobillon et al., 2011; Moreno-Monroy et al., 2018; Ioannides, 2013; Topa and Zenou, 2015). Indeed, starting with the pioneering works of Kain (1968), scholars have argued that through statistical discrimination, a lack of information and longer commuting times, while later studies argued for the role of neighborhood effects on school performance and criminality. This literature shows that residential segregation, i.e. the unequal distribution of income across space, can have important consequences on individual trajectories. On the flip side of the coin, gentrification, that is the arrival of numerous upper-middle class households in previously deprived neighborhoods, can displace former populations and be a source of conflicts, as attested by anti-gentrification protests all around the world (e.g London, Berlin, Brooklyn or Portland).

On the other hand, access to public services is not uniform across space, public transport infrastructures being a prime example. In France for instance,

72% of the national territory, housing 27% of the country's population, is not covered by any urban transit authority and a fortiori any local public transport network (Union des Transports Publics et ferroviaires, 2019), while only 14% of French municipalities have a train station with more than six trains a day (Gaudremeau, 2014). These inequalities in the access to transport infrastructures can moreover interact with and reinforce spatial inequalities in employment (Gobillon et al., 2011) or education (Moreno-Monroy et al., 2018).

The goal of this thesis is to better explain the relationships between public policies and spatial inequalities, by exploring on the one hand the impact of local policies on income segregation, and on the other hand how the institutional context can shape the provision of local public goods.

In the first chapter, I explore the impact of transport policies on spatial income disparities within cities, focusing on the impact of commuting costs on income sorting — i.e. the location choice of rich and poor workers. The literature has mostly emphasized amenities, school quality and place-based policies to explain income stratification (Lee and Lin, 2018; Koster and Rouwendal, 2017; Glaeser et al., 2018; Garcia-López et al., 2018; Couture and Handbury, 2020; Couture et al., 2018, amongst others). Yet, between cities comparisons show that city structure does impact segregation (Garcia-López and Moreno-Monroy, 2018) indicating that jobs concentration and transport infrastructures might influence segregation.

To separate the effects of amenities and transport infrastructures, and capture the potential interactions between amenities and transport networks, I build a quantitative spatial equilibrium model that takes into account workers sorting and the endogenous adjustment of labor, housing markets and amenities to workers location choice. The model is then calibrated on the city of Paris, and counterfactual simulations are used to assess the effects of a) of the Regional

Express Rail network (RER) and b) driving restrictions on the extent of spatial inequalities in the greater Paris region.

Model simulations show that the RER train system allowed to decrease spatial income disparities, both in terms of the income premium of Paris relative to the suburbs, and in terms of the total variation of mean incomes between municipalities across the area. Further, its sizable positive welfare effects benefited disproportionately low-skilled workers, allowing to reduce welfare inequalities.

On the other hand, the model predicts that banning cars from the inner city of Paris would foster suburbanization, which would allow to decrease the income inequalities between Paris and its suburbs. Although this would come at the cost of a loss in total welfare (of the same magnitude as the positive effect of the RER network), this loss would be higher for low-skilled workers, implying positive redistributive effects for the policy. The effects do however depend on the amenity gains that would be brought about by the policy, in terms of pollution reduction or cosmetic improvements. The model predicts that it would take a more than 10% increase in amenities in the inner city for the policy to break even and start having positive welfare effects. At that point however, the redistributive effects of the policy would be reversed, as it would start benefiting more the affluents and increasing income inequalities between the center and the suburbs.

Overall, this chapter shows that transport policies have the potential to reduce spatial inequalities. Further, it shows that policies that reduce transport emissions do not have to increase welfare inequalities, and can even have positive redistributive effects, in particular for those that rely on increasing the supply of public transit infrastructures.

In the second and third chapters, I turn to the recent trend towards re-centralization in developed countries. Following decades of decentralization and

increasing jurisdictional fragmentation, several countries have pushed programs of municipal mergers and inter-municipal cooperation (e.g. France, Italy, Germany, Great-Britain, Spain, Portugal and Brazil).

In the second chapter, we review the institutional forms of fiscal consolidation, and summarize the economic literature on the goals and consequences of these policies, that we supplement with an empirical analysis of the effects of the cooperation of French municipalities on their attractiveness and the income of their residents. Two mechanisms could link cooperation to population and incomes. The first one is location choice. If households take into account public services and taxes when making residential choices, the increased efficiency in public goods provision that cooperation was supposed to bring about should increase the attractiveness of cooperating municipalities compared to isolated ones. The second one is firms localization and agglomeration effects. Indeed, a reduction in fiscal cooperation should favor more central locations, which would lead to an increased concentration of firms in the center. While we find positive and significant effects of cooperation on median incomes, we do not find any evidence of an impact of cooperation on populations.

The theoretical justifications for inter-municipal cooperation are threefold: to reduce tax competition, to internalize spillovers and to benefit from increasing returns to scale in the provision of local public services. The empirical evidence on whether or not these goals were met are not clear. While [Ferraresi et al. \(2018\)](#) found a reduction in spending following cooperation in Italy, [Breuillé et al. \(2018\)](#) found a substantial increase in taxes in the case of France.

In the third chapter, we use data on the revenues and expenditures of French municipalities and their cooperation groups, as well as data about the particular missions transferred to the groups, to explore whether and where this additional tax revenue was spent. Using a difference in differences estimation strategy, we

show that although municipal expenditures decreased, the total expenditures of the municipal group (municipality plus cooperation group) increased strongly (an average of 21% compared to the year before cooperation). Further, we argue that this increase was not driven by wage bill expansion, which could have been the case if the creation of a new layer of government increased costs by creating redundancies.

As such, this result shows that scale economies, if existent, were dominated by either a reduction in tax competition or an increase in the production of public goods. Looking at expenditures by function, we find that the increase in expenditures was driven by general expenditures and urban policies. Further, by estimating the effect of transferring particular missions to the group, conditional on already cooperating, we show that a quarter of our estimated increase in spending can be explained by the transfer of three policies: public transit, economic development and garbage collection. We argue that these policies are likely to exhibit increasing returns in their *benefits*, meaning that the provision of these services should increase with the size of the jurisdiction that provides them. This implies that the increase in expenditures could be driven by an increase in the supply of these services, consistent with [Tricaud \(2019\)](#) who finds a large increase of the probability to be connected to a public transport network after cooperation.

Overall, the conclusion of this chapter is that a significant share of the increase in expenditures induced by the cooperation of French municipalities can be explained by a “zoo effect”, whereby cooperation allowed to increase the provision of some services that municipalities were too small to offer by themselves.

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Chapter 1

Transport Infrastructures and Income Disparities Within Cities

Abstract

This chapter studies the effect of transportation networks on spatial inequalities and redistribution within metropolitan areas. To do so, I build and calibrate a spatial equilibrium model of a city that features non-homotheticities and worker heterogeneity, allowing to capture rich patterns of workers sorting on commute costs and amenities. I then calibrate the model to the Paris urban area and use counterfactual simulations to study the effects of a) the Regional Express Rail and b) restricting car use in the city center. I find that on top of having a strong contribution to suburbanization and reducing welfare inequalities, the public transport network reduced income segregation in the area. Turning to the prospective effects of banning cars in the city center, the model predicts a reduction of the income disparities between Paris and its suburbs, at the cost of a substantial welfare loss.

Keywords commuting, amenities, income sorting, stratification

1.1 Introduction

In Europe, almost a quarter of greenhouse gas emissions comes from the transportation sector, of which 72% comes from road transport.¹ In the US, these figures are respectively 28% and 59%.² To fight global warming and local pollution, cities around the world are trying to promote greener ways of commuting. In Paris for instance, the city plans to ban all thermal vehicles before 2030.³ On the other hand, segregation and spatial inequalities are another major challenge faced by cities all over the world. With the French Riots and the more recent Yellow Vests movement, anti-gentrification protests in London, Leipzig, Brooklyn or Seattle, the negative consequences of spatial inequalities can be seen in all major cities in the world.

Most of the literature on sorting has emphasized the role of amenities (Lee and Lin, 2018; Koster and Rouwendal, 2017; Glaeser et al., 2018; Garcia-López et al., 2018; Couture and Handbury, 2020; Couture et al., 2018), school spending (Epple et al., 2001; Calabrese et al., 2006; Rothstein, 2006, e.g.) and place-based policies (e.g. González-Pampillón et al., 2019) on income stratification.⁴ Yet, comparisons between cities show that polycentric cities that concentrate economic activity in peripheral sub-centers are less segregated than their monocentric counterparts (Garcia-López and Moreno-Monroy, 2018). This seems to indicate

¹*Greenhouse gas emissions from transport in Europe.* European Environment Agency, <https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12>, accessed on August 21, 2020.

²*Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990–2018.* EPA 430-R-20-02.

³*Plan Climat*, available in French and English at <https://www.paris.fr/pages/nouveau-plan-climat-500-mesures-pour-la-ville-de-paris-5252>, accessed on August 21, 2020.

⁴Two exceptions are the concurrent studies of Tsivanidis (2019) and Gagné et al. (2019). Tsivanidis (2019) uses a similar model to estimate the welfare effects of the TransMilenio rapid bus network in Bogotá. However, he does not focus on income stratification, nor does he consider the effects of legislation on car use. Gagné et al. (2019) on the other hand do not model transport mode choice, and thus do not explore the effects of precise policies.

that job location and commuting are to be taken into account to explain spatial income distributions, so that one can wonder if it is possible to fill two needs with one deed and use transport improvements to reduce segregation.

To assess the stratifying and redistributive effect of transportation policies, I rely on the calibration and simulation of a quantitative spatial equilibrium model of a city. More precisely, I extend the model of [Ahlfeldt et al. \(2015\)](#) to introduce workers heterogeneity, both in terms of observable skill classes and unobserved talent/productivity. Within skill group, the income sorting of workers is governed by non-homotheticities in the preferences for housing, stemming from Stone-Geary preferences. These preferences imply that the willingness to pay rents in return for higher amenities and shorter commutes increases with income. I then calibrate the model to the Paris region and use model simulations to evaluate two transport policies: a) the Regional Express Rail (RER) and b) banning cars in the city.

The case of Paris is interesting for two reasons. First, it is a major European city, comparable in size, segregation and inequalities to other major metropolitan areas. Second, the impact of the RER has been studied previously using convincing IV strategies ([Mayer and Trevien, 2017](#); [Garcia-López et al., 2017](#)). It is thus possible to benchmark the model against some known results in the literature.

I find that the Regional Express Rail had a negative effect on spatial income inequalities. Overall, the RER train system decreases the between-municipality coefficient of variation of mean incomes by 1.9%, and the income premium of Paris with respect to its suburbs (10 to 15 kilometers away from the geographical center of the city) by 3.7%. Further, it has sizable positive welfare effects. Indeed, it accounts for 3.32% of the welfare of low-skilled workers and 2.56% of the welfare of high-skilled workers, reducing welfare inequalities by 0.8%.

Turning to the car ban counterfactual, when focusing on commuting costs the model predicts that the policy would foster suburbanization, leading to a decrease of the income premium of the city relative to the rest of region. Comparing with the close suburbs, the income premium of the city would drop by 14% (€1500). This would however come at the cost of a substantial welfare loss, of 2.6% for low-skilled and 3.2% for high-skilled workers. However, these effects depend on the amenity gains from the policy. It would require a more than 10% increase in amenities in Paris from pollution reduction and regained floor space for the policy to break even and start having a positive welfare effect. At that point, the sorting effects of the policy would be reversed: the income premium of the city would increase by 7%. As richer workers bid for floor space in this high-amenity center, the effect on welfare inequalities also flips, and the policy starts benefiting more the affluents.

The chapter also provides new within-city estimates of agglomeration effects on total factor productivity, skill bias of agglomeration effects and residential amenities spillovers. Agglomeration effects and residential amenity spillovers are estimated using model-based instruments, as introduced by [Allen et al. \(2020\)](#). I find agglomeration effects comparable in size to previous results using between-cities designs ([Ahlfeldt and Pietrostefani, 2019](#)), but substantially lower than other within-city estimates as [Ahlfeldt et al. \(2015\)](#) and [Tsivanidis \(2019\)](#). Keeping city structure constant, the elasticity of TFP to total city population is 0.04.

The first contribution of this chapter is to quantify the effects of transport policies on spatial income disparities. Several studies have shown the decentralizing effects of public transit and road infrastructures on employment and population gradients (e.g. [Mayer and Trevien, 2017](#); [Garcia-López et al., 2017](#); [Garcia-López, 2012](#); [Gonzalez-Navarro and Turner, 2018](#); [Baum-Snow, 2007](#)),

but none has quantified the effects of public transports or road accessibility on income segregation.

Second, the chapter extends the existing results on the effects of the Regional Express Rail on suburbanization. [Mayer and Trevien \(2017\)](#) use an IV strategy to estimate the causal impact of being connected to the Parisian Regional Express Rail network on a subset of municipalities. They conclude to a sizeable suburbanization effect on both employment and residential populations, with a stronger effect for high skilled workers. I add to their results by estimating the impact of the RER network on income sorting in the area.

Finally, the present chapter also contributes to the literature on within-city quantitative spatial equilibrium models. Several recent studies in urban economics use a similar structural approach ([Couture and Handbury, 2020](#); [Almagro and Domínguez-Iino, 2019](#); [Gaigné et al., 2019](#); [Tsivanidis, 2019](#)). I provide several robustness checks for the model fit, and make the case that this class of models can be used as stand-alone tools for policy evaluation. Indeed I estimate the model without targeting any particular policy and show that the model-based estimates are in line with reduced-form results on the RER network from [Mayer and Trevien \(2017\)](#). This lends credibility to using the model in cases where no natural experiment is available. Moreover, I estimate the housing consumption parameters that govern workers sorting on expenditure micro-data without targeting income disparities, and show that the model is able to fit the income sorting patterns in the data with those theoretically consistent parameters. Further, while I estimate amenities as structural residuals of the model as in [Albouy \(2016\)](#) and [Ahlfeldt et al. \(2015\)](#), I show that model-based amenities strongly correlate with observed amenities.

The remainder of the chapter is organized as follows. Section 1.2 presents the model and discusses the mechanisms that lead to income sorting. Section

1.3 describes the estimation and calibration of the parameters of the model and local amenities. Section 1.4 discusses results. Finally, section 1.5 concludes.

1.2 Model

This section outlines the model and discusses workers sorting. The general structure of the model is similar to Ahlfeldt et al. (2015), with the addition of workers heterogeneity and Stone and Geary preferences.

1.2.1 Workers behaviour

A city or urban area is composed of S municipalities, denoted by i or j , each endowed with some land L_j . There are H workers in the city. Each worker has to choose in which municipality to live and in which municipality to work. Workers are perfectly mobile and receive their income from supplying labour to firms in their workplace. Firms use labour and floor space to produce a final good costlessly traded with the rest of the world.

There are two sources of heterogeneity in the model. First, workers are endowed with an observed type e , corresponding to their education level. Second, within skill classes, workers differ in their individual skills and abilities, denoted $l \in \mathbb{R}_+$. Following the canonical literature on the estimation of agglomeration economies (e.g. Combes et al., 2008) workers heterogeneity within observed skill classes is modeled in terms of efficient labour supply differences. More precisely, a worker with ability l is assumed to supply l units of efficient labour. Therefore, given wages per efficient labour unit w_{je} for education e in municipality j , a worker with ability l simply receives an income of lw_{je} . The distribution of skills in the city for each type e is fix and denoted \mathcal{F}_e .

In what follows, education level indices are omitted when they are not necessary.

Conditional on her place of residence $i = 1, \dots, S$ and her workplace $j = 1, \dots, S$, agent n with ability l receives a wage lw_j , that she spends on a quantity

x_{ijn} of the numéraire good and a quantity f_{ijn} of floor space. The numéraire is not subject to transport costs, and is therefore distributed at a constant price (normalized to unity) everywhere in the city. The budget constraint of n is thus

$$lw_j = Q_i f_{ijn} + x_{ijn}, \quad (1.1)$$

where Q_i is the residential floor space rent in municipality i .

Regarding workers preferences, I focus on the sorting of workers on the basis of local amenities, which precludes the use of homothetic preferences. Following Gagné et al. (2019) and Tsivanidis (2019) and departing from the Cobb-Douglas specification in Ahlfeldt et al. (2015), I assume that workers have Stone and Geary preferences

$$U_{ijmn} \equiv z_{ijmn} B_{ijm} t_{ijm}^{-\tau_m} \left(\frac{x_{ijn}}{1 - \beta} \right)^{1-\beta} \left(\frac{f_{ijn} - \underline{f}}{\beta} \right)^\beta, \quad (1.2)$$

where $B_{ijm} = B_i T_j$ are the local amenities perceived when living in i , working in j . They include B_i the proper residential amenities in i and the niceness of the workplace j besides its offered wage, T_j . Second, $t_{ijm}^{-\tau_m}$ is the utility cost of commuting between i and j using transport mode m , with t_{ij} the travel time and τ_m a mode-specific disutility parameter. The random variable z_{ijmn} captures idiosyncratic preferences of n for the commute ij and transport mode m , and $\beta \in (0, 1)$ and $\underline{f} \geq 0$ are parameters that govern workers preferences for housing. \underline{f} has a natural interpretation as an incompressible floor space consumption.

Stone and Geary preferences have many interesting properties. First, whenever $\underline{f} > 0$, the (indirect) marginal rate of substitution between floor space costs Q_i and local amenities B_{ij} is increasing with income. This induces a relatively higher willingness to pay for high amenity levels for rich households than for poor households. It provides a parsimonious and theoretically sound foundation

for income sorting on the basis of amenities. When $\underline{f} = 0$ preferences are simple Cobb-Douglas.

Second, Stone and Gary preferences imply that the share of total income spent on housing is decreasing with income. This decrease is consistent with data on the housing consumption of French households. Indeed, our analysis of Expenditure Survey data in section 1.3.1 reports downward Engel curves ranging from 50% to 18% and shows that Stone and Geary preferences fit these curves well (cf Figure 1.2, section 1.3.1). This is in line with previous evidence using French data from Combes et al. (2018, p. 32, Table 6) who estimate that the share of housing in French households expenses is significantly decreasing in income. By maximizing (1.2) subject to the budget constraint (1.1), the individual demand for the private good (1.3), the individual demand for floor space (1.4), and the indirect utility of n when she chooses the commute ij (1.5) are respectively:

$$x_{ijn}^*(l) = (1 - \beta)(lw_j - Q_i \underline{f}) \quad (1.3)$$

$$f_{ijn}^*(l) = \beta \frac{lw_j}{Q_i} + (1 - \beta) \underline{f} \quad (1.4)$$

$$V_{ijmn}(l) = z_{ijmn} B_{ij} t_{ijm}^{-\tau_m} (lw_j - Q_i \underline{f}) Q_i^{-\beta}, \quad (1.5)$$

to the extent that these quantities are positive. When $lw_j - Q_i \underline{f} \leq 0$, i.e. when the worker cannot afford the incompressible floor space consumption in i by working in j , I set the indirect utility of the commute to $V_{ijmn}(l) = 0$.

In what follows, I assume that the idiosyncratic preference shock can be broken down into two components, $z_{ijmn} = \zeta_{ijmn} \xi_{ijn}$. The first term ζ_{ijmn} is the transport mode preference shock for worker n conditional on choosing commute ij , whilst the second one ξ_{ijn} captures idiosyncratic commute-specific preference shocks. Regarding the timing of the model, I assume that workers first learn

about z_{ijn} and choose a commute (i.e. simultaneously decide on a workplace and a residential location) accordingly. After they choose their commute, they learn about the transport mode shock ζ_{ijmn} and decide on which transport mode to choose.

The model is then solved by backward induction. Conditional on having chosen commute ij , workers have to decide on a transport mode m . Assuming that ζ_{ijmn} are independently and identically Fréchet distributed, with scale parameters a_m and shape parameter $\theta > 1$, workers expected utility over transport modes conditional on ij is

$$\xi_{ijn}v_{ij}(l) \equiv \mathbb{E} \left[\max_m V_{ijmn}(l) \right] = \xi_{ijn}B_{ij}t_{ij}^{\frac{1}{\theta}}(lw_j - Q_{i\underline{f}})Q_i^{-\beta}, \quad (1.6)$$

with $t_{ij}^{\frac{1}{\theta}}$ the expected transport utility:

$$t_{ij}^{\frac{1}{\theta}} = \left[\sum_m a_m t_{ijm}^{-\tau_m \theta} \right]^{\frac{1}{\theta}}. \quad (1.7)$$

As in Ahlfeldt et al. (2015), I assume that ξ_{ijn} the idiosyncratic preference shocks for commutes are independent draws from Fréchet distributions with shape parameter $\epsilon > 1$. Standard discrete choice theory (cf. Ahlfeldt et al., 2015, for a detailed exposition) then yields the probability for a worker with skill l to choose commute ij :

$$\pi_{ij}(l) \equiv \Pr[v_{ijn}(l) > v_{kmn}(l), km \neq ij] = \frac{v_{ij}(l)^\epsilon}{\sum_{i=1}^S \sum_{j=1}^S v_{ij}(l)^\epsilon} \equiv \frac{v_{ij}(l)^\epsilon}{v(l)^\epsilon}, \quad (1.8)$$

with $v(l)$ the *ex ante* expected utility of a worker with skill level l . When $lw_j < Q_{i\underline{f}}$ however, utility is zero and so is the numerator of the choice probability. Since $\epsilon > 1$, these choice probabilities are still smooth and differentiable for any

$w_j \in \mathbb{R}_+$ and any $Q_i \in \mathbb{R}_{++}$, as long as there is at least one commute in the city in which the worker can realize a positive utility.⁵

The total probability to reside in i for a worker with skills l , $\pi_i^R(l)$ (respectively working in j , $\pi_j^M(l)$) is the sum over workplaces j (respectively dwelling places i) of the bilateral probabilities:

$$\pi_i^R(l) = \frac{\sum_{j=1}^S v_{ij}(l)^\epsilon}{v(l)^\epsilon}, \quad \pi_j^M(l) = \frac{\sum_{i=1}^S v_{ij}(l)^\epsilon}{v(l)^\epsilon}. \quad (1.9)$$

Finally, the conditional probability to live in i when working in j is denoted $\pi_{ij|j}(l)$ and the probability to work in j conditional on living in i is denoted $\pi_{ij|i}(l)$:

$$\pi_{ij|j}(l) \equiv \frac{\pi_{ij}(l)}{\pi_{Mj}(l)}, \quad \pi_{ij|i}(l) \equiv \frac{\pi_{ij}(l)}{\pi_{Ri}(l)}. \quad (1.10)$$

Armed with these choice probabilities, that describe the spatial distribution of workers conditional on wages, rents and amenities, we can now discuss sorting.

1.2.2 The sorting of workers

When $\underline{f} > 0$, workers exhibit direct sorting both at the workplace and in their residential location choice. High ability workers are willing to forego more consumption than low ability workers for an increase in residential amenities or a decrease in travel times. They are also willing to forego more wage per unit of efficiency for an increase in workplace amenities or a decrease in travel times.

More precisely, use the conditional residential choice probability $\pi_{ij|j}$ to define the rate of substitution between rents and some commute characteristic X_{ij} as

⁵Thereafter, I will implicitly assume $lw_j > Q_i \underline{f}$ when writing down choice probabilities. If a worker gets too poor relative to floor space prices in the city, so that they cannot reach their incompressible floor space demand in any municipality, then it is simply assumed that they opt out from the city and leave.

the variation in rents in i necessary to keep the share of j workers living in i stable when the X_{ij} increase/decrease as

$$\left. \frac{dQ_i}{dX_{ij}} \right|_{d\pi_{ij|j}(l)=0} (l) = - \frac{\partial_{X_{ij}} \pi_{ij|j}(l)}{\partial_{Q_i} \pi_{ij|j}(l)}. \quad (1.11)$$

Direct computation of these quantities yields the following proposition:

Proposition 1.2.1. Whenever $\pi_{ij|j}(l) > 0$, we have $\left. \frac{dQ_i}{dB_i} \right|_{d\pi_{ij|j}(l)=0} (l) > 0$ and $\left. \frac{dQ_i}{dt_{ij}^{1/\theta}} \right|_{d\pi_{ij|j}(l)=0} (l) > 0$. Further, they are increasing in l if and only if $\underline{f} > 0$.

These elasticities are always positive, showing that all workers need to be compensated by a decrease in rents when amenities decrease or travel times increase. When $\underline{f} = 0$, i.e. when preferences are Cobb-Douglas, these elasticities boil down to $1/\beta$: every worker, rich or poor, skilled or unskilled, will keep her probability to choose a municipality constant when her rent increases by $1/\beta\%$ in exchange for a 1% increase in amenities or decrease in expected commuting times. In this case residential choice probabilities are independent of talent and wages: everything else equal, skilled and unskilled households make the same residential choices.

Whenever $\underline{f} > 0$ however, this elasticity is strictly increasing in l . This means that when amenities in i increase (or travel times between i and j improve), more productive and thus richer workers can accept a stronger increase in rents while keeping their probability to live in i constant. This is the basic direct sorting effect that is induced by non-homotheticities in housing demand, and that drives differences in residential location choices between rich and poor workers in the model, which mimicks the classical Alonso-Muth single-crossing property.

Turning to workplace choice, define in a similar fashion the rate of substitution between wages and commute characteristics, conditional on residential locations,

as

$$\frac{dw_j}{dX_{ij}} \Big|_{d\pi_{ij|i}(l)=0} (l) = -\frac{\partial_{X_{ij}}\pi_{ij|i}(l)}{\partial_{w_j}\pi_{ij|i}(l)}. \quad (1.12)$$

Then the following proposition follows

Proposition 1.2.2. Whenever $\pi_{ij|j}(l) > 0$, we have $\frac{dw_j}{dT_j} \Big|_{d\pi_{ij|i}(l)=0} (l) < 0$ and

$\frac{dw_j}{dt_{ij}^{1/\theta}} \Big|_{d\pi_{ij|i}(l)=0} (l) < 0$. Further, they are increasing in l if and only if $\underline{f} > 0$.

Whenever the commute has a positive probability to be selected, this quantity is strictly between zero and negative one, and monotonically decreasing with skills. All workers are willing to forego some income for an increase in their workplace quality (or a decrease in travel times), but for poorer workers the percentage increase needed to compensate a reduction in wages tends to infinity. This elasticity is also increasing in incompressible costs, so that everything else equal workers living in more expensive municipalities are less willing to forego wages for workplace niceness.

1.2.3 Aggregation

From individual choice probabilities, aggregate quantities at the municipal level can be computed as follows:

- Bilateral population in commute ij is given by summing residential probabilities over skill levels

$$H_{ij}^R = \bar{H} \int_0^\infty \pi_{ii}(l) d\mathcal{F}(l), \quad (1.13)$$

- Total effective labour flow on ij is given by summing the supply from all skills l

$$H_{ij}^M = \bar{H} \int_0^\infty l\pi_{ij}(l) d\mathcal{F}(l), \quad (1.14)$$

- Total income of residents in i is given by summing wages over workplaces and skill levels

$$W_i = \bar{H} \sum_j w_j \int_0^\infty l \pi_{ij}(l) d\mathcal{F}(l). \quad (1.15)$$

with \bar{H} the total population of the city. Finally, total labour supply in j is denoted $H_j^M \equiv \sum_i H_{ij}^M$ while total residential population in i is denoted $H_i^R \equiv \sum_j H_{ij}^R$.

Moreover, from the Fréchet preference shock the expected utility is given by (cf. Ahlfeldt et al., 2015, for a proof)

$$\mathbb{E}(U|l) = \left[\sum_{i=1}^S \sum_{j=1}^S [\tilde{B}_{ij}(lw_j - Q_i f) Q_i^{-\beta}]^\epsilon \right]^{\frac{1}{\epsilon}}, \quad (1.16)$$

so that the total welfare of workers is

$$\mathbb{E}(U) = \int \mathbb{E}(U|l) d\mathcal{F}(l). \quad (1.17)$$

1.2.4 Production

Production in each municipality is assumed to be Cobb-Douglas over workforce \bar{H}_j^M and floor space F_j^M , with a share of floor space α :

$$y_j = A_j (\bar{H}_j^M)^{1-\alpha} (F_j^M)^\alpha, \quad (1.18)$$

where A_j is a total factor productivity (TFP) term that varies between municipalities. Labor supply is assumed to be a CES aggregate of total efficient labor units for high-skilled workers H , H_j^H and low-skilled workers L , H_j^L , with an

elasticity of substitution σ and high skill bias A_j^S :

$$\bar{H}_{Mj} = \left[A_j^H (H_j^H)^{\frac{\sigma-1}{\sigma}} + (1 - A_j^H) (H_j^L)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}. \quad (1.19)$$

Further, firms pay a rent Q_j per unit of floor space and a wage index \bar{w}_j per unit of aggregate labor. Under these assumptions, the profit of firms in j is thus

$$A_j (H_{Mj})^{1-\alpha} (F_{Mj})^\alpha - Q_j F_{Mj} - \bar{w}_j \bar{H}_{Mj}. \quad (1.20)$$

The first order conditions of profit maximization give the demand for commercial floor space, given workforce:

$$F_{Mj} = \frac{\alpha}{1-\alpha} \frac{\bar{w}_j \bar{H}_{Mj}}{Q_j}. \quad (1.21)$$

Moreover, the zero profits condition has to hold if profit maximizing firms operate in municipality j :

$$A_j = \left(\frac{Q_j}{\alpha} \right)^\alpha \left(\frac{\bar{w}_j}{1-\alpha} \right)^{1-\alpha}. \quad (1.22)$$

Finally, from the assumption of CES labor aggregate, the wage index \bar{w}_j is

$$\bar{w}_j = \left[A_j^H (w_j^H)^{1-\sigma} + (1 - A_j^H) (w_j^L)^{1-\sigma} \right]^{\frac{1}{\sigma-1}}. \quad (1.23)$$

1.2.5 The market for floor space

We assume that floor space is produced by a competitive development sector under CRS technology, using elastically supplied capital and land that is completely inelastically supplied. This implies an elastic supply of floor space, with a price elasticity inversely proportional to the share of land in the construction technology of the construction sector.

Formally, F_i the total floor space in i , available for both commercial and residential use, is supplied by a competitive development sector. Following Combes et al. (2017), developers use land L_i with rental price R_i and capital K_i with rental price P (common to all locations) as inputs to a CRS Cobb-Douglas technology:

$$F_i = C_i K_i^{1-\mu} L_i^\mu.$$

Developers treat land available for construction as given and fixed, $L_i = \bar{L}_i$,⁶ and maximize their profit by choosing how much capital to invest for land development in i . Profit maximization gives the following supply function:

$$F_i = \tilde{L}_i Q_i^{\tilde{\mu}},$$

where $\tilde{L}_i \equiv \bar{L}_i C_i^{1/\mu} (\frac{1-\mu}{P})^{(1-\mu)/\mu}$ is a measure of land in i corrected by the easiness to build in i and $\tilde{\mu} \equiv \frac{1-\mu}{\mu}$ is the rent elasticity of floor space supply.

On the demand side, the demand of floor space from firms is given, as a function of workforce, by equation (1.21). For residents, total demand can be computed by aggregating the individual demand in (1.4) over skills and commute probabilities:

$$F_{Ri} = \beta \frac{W_i}{Q_i} + (1 - \beta) H_i^R,$$

where W_i and H_{Ri} are total income and residential populations respectively, as per equations (1.15), and (1.13). Therefore, the market clearing condition is given by equating supply to both these demands:

$$\tilde{L}_i Q_i^{\tilde{\mu}} = \frac{\alpha}{1 - \alpha} \frac{\bar{w}_i \bar{H}_i^M}{Q_i} + (1 - \beta) \underline{f} H_i^R + \beta \frac{W_i}{Q_i}. \quad (1.24)$$

⁶Assuming that the supply of land is fixed does not seem to be a strong assumption in an urban context, where alternative uses of land such as agriculture are not a concern.

1.2.6 Agglomeration effects and spillovers

Local TFPs are allowed to depend on local workforce density:

$$A_i = \tilde{A}_i \left[\sum_j \exp(-\rho^A d_{ij}) \frac{\bar{H}_j^M}{L_j} \right]^{\lambda^A}, \quad (1.25)$$

where λ^A is the elasticity of TFP to total workforce in the city, while ρ^A is a spatial decay parameter measuring the reach of productivity spillovers.

High-skilled bias is allowed to depend on density in a similar way:

$$\frac{A_i^S}{1 - A_i^S} = \tilde{A}_i^S \left[\sum_j \exp(-\rho^S d_{ij}) \frac{\bar{H}_j^M}{L_j} \right]^{\lambda^S}. \quad (1.26)$$

Finally, residential amenities depend on a local market potential that aggregates total residential income around every location:

$$B_i = \tilde{B}_i \left[\sum_j \exp(-\rho^B d_{ij}) \frac{\bar{W}_j}{L_j} \right]^{\lambda^B}. \quad (1.27)$$

1.2.7 Equilibrium

Assume one type of workers to ease notations.

Definition 1.2.1 (Equilibrium). An equilibrium of the model, conditional on parameter values $\{\beta, \underline{f}, \epsilon, \alpha, \rho, \eta, \delta, \lambda\}$, exogenous amenities (b_i), exogenous total factor productivity shifters (a_i), land areas (\tilde{L}_i) and total city population H , is a set $\{(H_{ij}^M, H_{ij}^R)\}$ of number of workers and skill flow per commute so that:

1. the profit maximization condition for firms (1.22) holds

$$A_i = \left(\frac{Q_i}{1 - \alpha} \right)^{1-\alpha} \left(\frac{w_i}{\alpha} \right)^\alpha;$$

2. the market for floor space clears according to equation (1.24)

$$\tilde{L}_i Q_i^{\tilde{\mu}} = \left(\frac{(1-\alpha)A_i}{Q_i} \right)^{\frac{1}{\alpha}} H_{Mi} + (1-\beta)fH_{Ri} + \beta \frac{W_i}{Q_i};$$

3. amenities are given by equation (1.27);

$$B_i = b_i \left[\sum_{j=1}^S \exp(-\rho t_{ij}) W_j \right]^\eta;$$

4. TFPs are given by equation (1.25);

$$A_j = a_j \left[\sum_{k=1}^S \exp(-\delta t_{jk}) \left(\frac{H_{Mk}}{L_k} \right) \right]^\lambda.$$

5. Flows are in equilibrium:

$$\begin{aligned} H_{ij}^M &= H \int_0^\infty l \pi_{ij}(l) d\mathcal{F}(l), \\ H_{ij}^R &= H \int_0^\infty \pi_{ij}(l) d\mathcal{F}(l). \end{aligned}$$

Proposition 1.2.3 (Equilibrium existence). Assume that floor space supply elasticity is strictly positive, $\tilde{\mu} > 0$, and that the support of \mathcal{F} is unbounded. Then an equilibrium exists for this economy.

Table 1.1: List of parameters, estimation methods and sources.

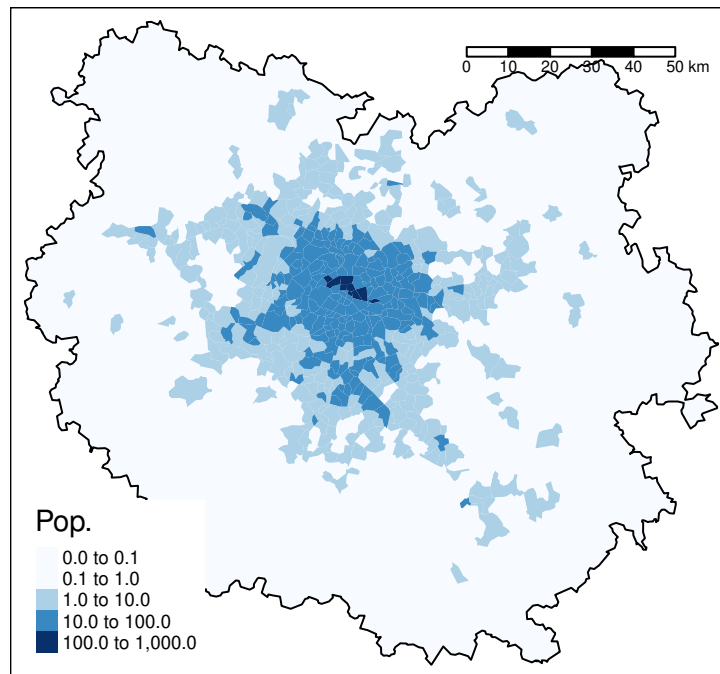
Quantity	Description	Method	Source*	Sect.
ϵ	Taste shock dispersion	Calibrated	Ahlfeldt et al. (2015)	1.3.1
τ	Utility cost of commuting	Estimated on commuting flows	DADS, TT, DVF	1.3.1
\underline{f}	Subsistence floor space quantity	Estimated on spending data	Expenditure survey	1.3.1
β	Floor space preference parameter	Estimated on spending data	Expenditure survey	1.3.1
w_1, \dots, w_J	Local wages	Estimated on individual wages	DADS	1.3.2
\mathcal{F}^e	Talent distribution	Estimated on individual wages	DADS	1.3.2
ρ, λ	Spillovers	Estimated, model-based instruments	DADS, TT, DVF	1.3.6
α	Floor space share in prod.	Calibrated from macro data	National Accounts	1.3.3
σ	Skill complementarity	Calibrated from literature	Wingender (2015)	1.3.3
$\tilde{\mu}$	Building supply elasticity	Calibrated from literature	Combes et al. (2017)	1.3.4
A_1, \dots, A_J	TFP	Residuals, zero profits condition	DADS, DVF	1.3.3
B_1, \dots, B_J	Residential amenities	Residuals, location choice	DADS, TT, DVF	1.3.5
T_1, \dots, T_J	Workplace niceness	Residuals, location choice	DADS, TT, DVF	1.3.5

*: See text in appendix 1.C for a description of the data.

1.3 Data and calibration

For the rest of the chapter, I calibrate the model on the Urban Areas of Paris, in 2015 (represented in Figure 1.1). It is by far the biggest Urban Area in the country, and the one that exhibits the highest levels of spatial inequalities both in terms of rents and wages. It has been a major commercial and cultural hub for most of the country's history, and thus offers important historical and cultural amenities.

Figure 1.1: Residents per km^2



For the delineation of the city, I use the National Statistical Institute *Aires Urbaines* 2010, that are constructed by sequential aggregation of municipalities around employment centers based on commuting flows. There has recently been a renewed interest in the literature about methods for delineating Urban Areas (see e.g. de Bellefon et al., 2020). For the purpose of the present chapter, because

the adjustment of the rent gradient is a key mechanism driving workers sorting as a response to changes in commuting costs, it is important that the limitations to urban sprawl imposed by the urban area boundaries do not influence the results. As illustrated in Figure 1.1, the definition used here allows for a wide buffer of low density areas (less than $1 h/km^2$) around the city center, which means that relaxing commuting costs should not introduce artificial land scarcity.

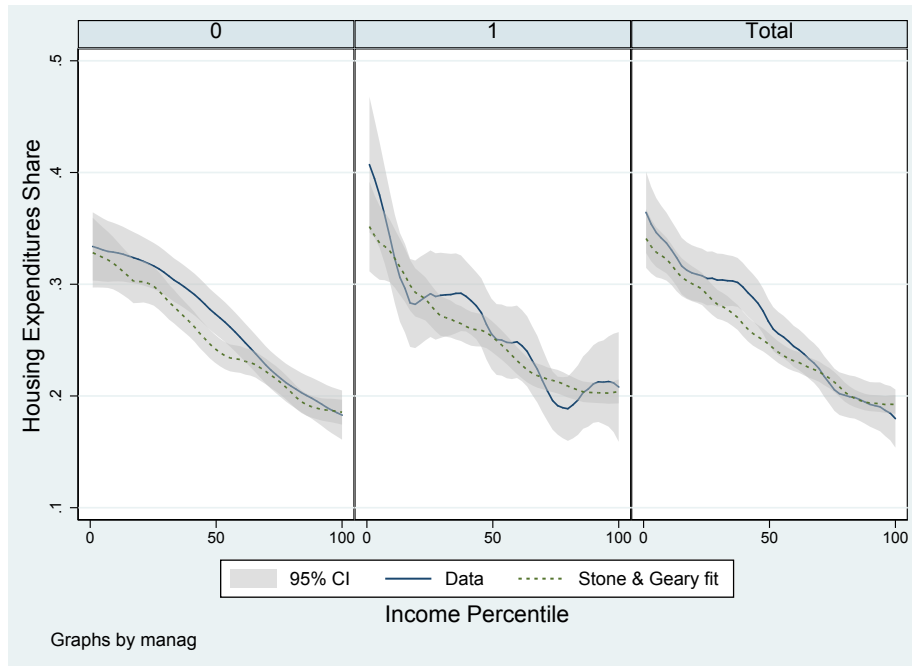
Table 1.1 lists the parameters and fundamentals of the model, and the source and methods used to estimate or calibrate them.

1.3.1 Workers preferences

The taste shock dispersion parameter ϵ corresponds to the elasticity of commute choice to changes in real incomes. Several papers have estimated this quantity. Ahlfeldt et al. (2015) find values ranging from 6.6 to 6.8 depending on specifications using German historical data. Preferred estimate of Couture and Handbury (2020) is equal to 3, estimated on US data, while Monte et al. (2018) estimate a parameter equal to 3.3, still on US data. On Dutch data, Almagro and Domínguez-Iino (2019) reports coefficients ranging from 1.6 to 7 depending on household type. I settle for the mid-point and calibrate $\epsilon = 5$.

Housing consumption The Stone and Geary demand parameters, β and \underline{f} , are estimated separately for high and low skilled workers on housing expenditure from the Expenditure Survey data. This dataset gives monthly expenditures on housing, total floor space of the dwelling unit, monthly rent for the housing unit, monthly income and the number of workers for a sample of French households in 2006 and 2011. I restrict the sample to households from the Paris Area with at least one working member. From the Stone-Geary specification of utility, the

Figure 1.2: Engel curve: data and Stone-Geary fit



Expenditure Survey data vs. Stone-Geary fit (predicted income). Unskilled workers (0), Skilled workers (1) and Total.

share of income dedicated to housing is given by (1.4):

$$s_n = \frac{Q_n f_n^*}{w_n} = \beta + (1 - \beta) \underline{f} \frac{Q_n}{w_n}.$$

In the expenditure data, I compute income by active workers w_n by dividing the total salary of the household by the number of working members, and I do the same with household rents to obtain rents per worker. Keeping only households with above minimal wage workers and expenditure shares below one, the resulting Engel curve, pooling high and low skilled workers, is plotted in Figure 1.2. It is downward slopping, and the Stone-Geary specification estimated below is able to fit this relationship quite well.

Table 1.2: Estimates of housing preference parameters.

	Raw income		Predicted income	
	L. Skill	H. Skill	L. Skill	H. Skill
β	0.149 (0.0096)	0.140 (0.0137)	0.129 (0.0096)	0.132 (0.0134)
\underline{f}	21.62 (1.290)	29.32 (2.542)	23.13 (1.321)	27.15 (2.889)
r2	0.431	0.529	0.392	0.332
N	505	329	505	329

Standard errors in parenthesis. Raw income and predicted income are defined in the text.

To estimate \underline{f} and β for each worker type, I run the following regression

$$s_n = \beta + (1 - \beta)\underline{f}\frac{Q_n}{w_n} + \tilde{\beta}_n,$$

with $\tilde{\beta}_n$ an individual error term capturing idiosyncratic variations in the marginal propensity to spend on housing. In columns (1) and (2) of Table 1.2 I report OLS estimates of β and \underline{f} from this equation. The marginal propensity to spend, β , is estimated to be 0.149 for low-skilled workers and 0.140 for high-skilled workers. Incompressible floor space demand \underline{f} is estimated to be higher for high-skilled workers (29.32 sq. meters) than for low-skilled workers (21.62 sq. meters). Note that these estimates pertain to the minimum floor space consumption per worker. With an average of 0.656 inactive household member per worker in the sample, these estimates thus correspond to 12 sq. meters per person for low-skilled workers and 17.7 sq. meters per person for high-skilled workers. As pointed out by Tsivanidis (2019), the slope of the Engel curve, and thus the estimate of \underline{f} in this regression, could be overestimated if incomes are volatile.

As workers cannot adjust housing consumption instantaneously, shocks to w_n the year of the survey would inflate or deflate both Q_n/w_n and s_n , leading to an inflated estimate of $(1 - \beta)\underline{f}$. To test the sensibility of the parameters to this issue I construct predicted incomes \hat{w}_n by regressing individual incomes on 4-digits occupation codes and estimate the same OLS regression using these predicted incomes. The results of the regression on predicted income are reported in columns (3) and (4) of Table 1.2. With predicted incomes, the marginal propensity to spend is estimated at 0.129 and 0.132 respectively for high and low-skilled workers, and incompressible floor space is respectively 23.13 and 27.15. For the rest of the analysis, I set β and \underline{f} to these estimated values. They are close to the raw income estimates, and the following results are not sensitive to using either one of them.

Table 1.3: Transport mode choice.

	Low skill	High skill
Car time	-2.245*** [-2.279,-2.211]	-2.163*** [-2.208,-2.119]
Public transport time	1.798*** [1.771,1.824]	1.638*** [1.603,1.673]
Constant	-0.183*** [-0.242,-0.123]	0.0827 [-0.00108,0.166]
r2	0.358	0.343
N	34328	18870

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Transport costs From the specification of the transport mode choice problem in equation (1.7), the probability to choose to take the car versus public transport

conditional on living in i and working in j is

$$\Pr(c|ij) = \frac{a_c t_{cij}^{\tau_m \theta}}{a_c t_{cij}^{\tau_m \theta} + t_{pij}^{\tau_m \theta}}$$

where a_c is a parameter and t_{cij} and t_{pij} are travel times between i and j respectively by car and by public transport. I estimate a_c and $\tau_m \theta$ by OLS, regressing log odd-ratios for each location-destination-type pair on the log of travel times. The estimated coefficients are reported in Table 1.3. Estimated travel time elasticities are higher for travel times by car (2.245 for low skilled and 2.163 for low skilled) than for public transports (1.798 for low skilled and 1.638 for high-skilled). The magnitude of these parameters is in line with estimated travel time disutility parameters in the literature. Further, the estimated intercept is $a_c = -0.183$ for low-skilled workers, and 0.08 (not significantly different from zero at 5%) for high skilled workers, reflecting a higher preference for cars over public transports for high-skilled workers, irrespective of travel times. The expected utility of commuting between i and j , t_{ij} , is then (up to a multiplicative constant), given by equation (1.7). I then estimate the ratio of location choice dispersion to mode choice dispersion, ϵ/τ , by regressing commute flows on the expected disutility of travel times and origin and destination fixed-effects, running one separate regression per worker type:

$$\ln(\hat{s}_{ij}) = \delta_i + \delta_j - \frac{\epsilon}{\theta} \ln(t_{ij}) + e_{ij}.$$

As is common in the estimation of bilateral trade frictions, I report both OLS and PPML estimates to accomodate zeroes in the flows data. Table 1.4 reports the estimated elasticity of location choice to expected travel times disutility. The estimated parameter is slightly lower for High-skilled workers (1.238) than

Table 1.4: Estimates of the dispersion parameter of mode choice

	(1)	(2)	(3)	(4)
	OLS Low skill	PPML Low skill	OLS High skill	PPML High skill
Expected t.t. (ϵ/τ)	1.149*** (0.00345)	1.590*** (0.00896)	0.871*** (0.00425)	1.238*** (0.0178)
r2	0.633		0.603	
N	93385	484416	60854	484416

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

low-skilled workers (1.590). In the simulations, I set these parameters to their PPML estimates.

1.3.2 Municipal wages

In order to simulate the model, one needs to recover the distribution \mathcal{F}_l^H and \mathcal{F}_l^L of individual productivities l within each worker type (high-skilled H and low-skilled L) separately from the wages paid by firms per unit of labor in each municipality. To do so, I regress the log of individual wages $\ln(w_n^e)$ for worker n with type $e = H, L$ on a set of individual variables X_n and workplace-type fixed effects $\ln(w_j^e)$:

$$\ln(w_n^e) = \ln(w_j^e) + \theta X_n + \epsilon_n \quad (1.28)$$

Once municipal wages $\ln(w_j^e)$ are estimated, I attribute everything else to individual productivities: $\ln(l_n) = \hat{\theta} X_n + e_n$. In Table 1.5, I report descriptive statistics of the variations of local wages and individual productivities at the municipal level. While municipal effects have a higher explanatory power of municipal variations in wage than individual characteristics, we see that there appears to be positive sorting of the more productive workers within the most productive cities, as pointed out by the 0.22 correlation between average municipal individual productivities and municipal wages.

Table 1.5: Contribution of individual and local effects to mean wage at the municipal level.

	Standard Deviation	Correlation with (log) Mean wage	$\ln(w_j^e)$
(log) Mean wage	0.115	1.00	0.89
$\ln(w_j^e)$ (Local)	0.091	0.89	1.00
Mean individual effects	0.053	0.64	0.22

Standard deviation and correlation coefficients within skill groups, between municipalities. First row is mean municipal wage, second is the estimated fixed-effect, the last one is municipal averages of individual productivities $\ln(l_n)$.

1.3.3 Local productivities and technology parameters

The CES aggregator for unskilled and skilled labor (1.19) implies (log) labor demand ratios

$$\frac{w_j^H}{w_j^L} = \left(\frac{H_j^H}{H_j^L} \right)^{-1/\sigma} \frac{A_j^H}{1 - A_j^H}. \quad (1.29)$$

I set σ the elasticity of substitution between high and low skilled workers equal to 1.5, which is the consensus value in the literature (see e.g. Wingender, 2015, and references therein.). I then compute the skill-bias of labor demand in each municipality by inverting (1.29)

$$\frac{A_j^H}{1 - A_j^H} = \frac{w_j^H}{w_j^L} \left(\frac{H_j^H}{H_j^L} \right)^{1/\sigma}$$

From the Cobb-Douglas technology on the upper nest of the production function $y_j = A_j \bar{H}_{Mj}^{1-\alpha} F_{Mj}^\alpha$, the production parameter α is equal to the share of floor space in firms costs. I compute this parameter in three ways. First, using aggregate national accounts, second by explicitly using commercial floor space data aggregated at the city level to compute the ratio of floor space expenditures

over wage bill, and finally by regressing floor space expenditures on wage bill at the municipal level.

National accounts from *INSEE* report that the share of capital (GFCF) represents 30% of value added, while building and land make up 55% of capital expenditures of French firms. Normalizing so that floor space and labor shares sum to one, we get a share of developed land of $\alpha = 0.55 \times 0.3 / (0.7 + 0.55 \times 0.3) = 19\%$.

Because of changing definitions of taxable commercial and professional floor space, land registers are not very reliable in their reporting of non-residential surfaces. Still, using non-residential floor space from those files and average rents per squared meter from the building transactions data, I obtain a share of floor space in firms costs of 26%. Finally, using those same data to regress floor space costs on total wage bill at the municipal level gives a coefficient of 0.28, implying a share $\alpha = 22\%$. Overall, the calibrated parameter from national accounts data is in line with raw correlations in the micro data, and I calibrate $\alpha = 20\%$.

Given this parameter, wage index \bar{w}_j and rents Q_j for each municipality j , I compute TFPs from the zero profits condition

$$A_j = \left(\frac{\bar{w}_j}{1 - \alpha} \right)^{1-\alpha} \left(\frac{Q_j}{\alpha} \right)^\alpha .$$

1.3.4 Construction sector

For the construction sector technology, I calibrate the share of land in the production of floor space μ to the estimates in [Combes et al. \(2017\)](#). For the city of Paris, they report elasticities to non-land inputs of 0.54 (Table 3). This gives a supply elasticity of $\tilde{\mu} = \mu / (1 - \mu) = 1.17$. Estimated long-term elasticities of housing supply in the literature for constrained cities range between 1 and 4

depending on the nature of the housing market. Saiz (2010) reports unweighted mean elasticities across US Metropolitan Areas (MSAs) of 2.5, while Harter-Dreiman (2004) reports ranges of elasticities of $[1 - 2.1]$ for constrained housing markets and $[2.6 - 4.3]$ for unconstrained cities, still in the US. This puts the calibrated elasticity for Paris in the range of long-run elasticities estimated for constrained housing markets in the US.

Given $\tilde{\mu}$ and households preference parameters, adjusted land areas \tilde{L}_i are computed for all i to solve the floor space market clearing equation in (1.24):

$$\tilde{L}_i = Q_i^{-\tilde{\mu}} \left(\frac{1 - \alpha \bar{w}_i \bar{H}_{Mi}}{\alpha} + (1 - \beta) \underline{f} H_{Ri} + \beta \frac{W_i}{Q_i} \right).$$

1.3.5 Amenities

Given individual preference parameters $\epsilon, \beta, \tau, \underline{f}$, local wages w_j^e for every municipality and type and floor space rents Q_i for every municipality, we can compute total income at the workplace and at the residential place for each worker type

$$\begin{aligned} W_i^{Re} &= H \sum_j w_j^e \int_0^\infty l \pi_{ij}(l) d\mathcal{F}^e(l), & e &= \{H, L\} \\ W_i^{Me} &= H w_j^e \sum_j \int_0^\infty l \pi_{ji}(l) d\mathcal{F}^e(l), & e &= \{H, L\}. \end{aligned}$$

I calibrate amenities B_i^e and labour supply shifters T_j^e to the unique values that match predicted total income to total income in the data for all i, j and e , conditional on preference parameters, wages and rents.

1.3.6 Spillovers and agglomeration effects

Having recovered TFPs A_j , skill bias A_j^S and residential amenities B_i^e , for $e = \{H, L\}$, I estimate the spillover parameters using a model-based instrument

approach à la [Allen et al. \(2020\)](#). The main concern with naive non-linear least square estimation of the spillover parameters ρ and λ in (1.25), (1.26) and (1.27), is that of the simultaneity of populations and exogenous amenities. Taking (1.25) as an example, the equation that we would like to estimate is

$$A_i = \left[\sum_j \exp(-\rho^A d_{ij}) \frac{\bar{H}_j^M}{L_j} \right]^{\lambda^A} \tilde{A}_i,$$

where \tilde{A}_i , the error term, is composed of exogenous variables that influence local productivity (e.g. natural advantages, access to rivers, slope, altitude, as well as unobserved infrastructures), besides agglomeration effects that are captured by the term in brackets. Because workers tend to move to high-TFP places to enjoy higher wages, \tilde{A}_i is likely positively correlated with \bar{H}_{Mj} the endogenous labor supply, so that we can expect naive estimates of λ to be biased upward.

This problem is not new, and there is a large body of literature concerned with designing ways to mitigate this endogeneity issue. The canonical approach (cf. [Combes and Gobillon, 2015](#)) is to instrument populations by long lagged values of itself, while controlling for geographical features that are likely to be part of \tilde{A}_j . The reasoning behind those instruments is that technological change has been such over the years that determinants of productivity that attracted populations centuries ago are not relevant anymore (at least conditional on controls), and only affect productivity in so far as they anchored populations. The identifying assumption that underlies this approach is thus that once we control for persistent geographical features that may be relevant for today's firms (such as climate or access to water) the factors that drove historical localization of manufacturing are not directly relevant to the localization of modern-day industries.

However, while the identifying assumptions are plausible in the case of productivity, their application to estimating residential amenity spillovers is more problematic. Indeed, in the case of residential amenities, one can argue that most of the natural features, views, monuments and historical prestige that drove the localization of residents a few centuries ago are still relevant to the location choice of modern workers. Especially within cities, where fine geographical features can make all the difference between a cold swamp and a nice riverside, it would be hard to argue that we have access to detailed enough control variables to make historical populations a valid instrument.

To recover these spillover parameters, I thus follow [Allen et al. \(2020\)](#) and use *model-based instruments*, constructed using exogenous variables that would have been used as controls in a traditional IV approach. The advantage of this approach is that we do not need an exhaustive list of control variables, as long as they have some relevance to location choice.

In short, the method goes as follows:

1. Regress model fundamentals (A_i, B_i, A_i^S) on a set of exogenous local characteristics Z_i (e.g. topographical characteristics), and predict $(\hat{A}_i, \hat{B}_i, \hat{A}_i^S)$ using Z_i .
2. Simulate the model using $(\hat{A}_i, \hat{B}_i, \hat{A}_i^S)$ and a first guess λ, ρ for the agglomeration and spillover parameters as inputs. Denote (\hat{H}_j^M) the simulated workforce and (\hat{W}_i) the predicted incomes.
3. Estimate $\hat{\lambda}$ and $\hat{\rho}$ from the structural equations (1.25), (1.26) and (1.27), using the simulated variables (\hat{H}_{Mj}) and (\hat{W}_i) as instruments, *whilst controlling for Z_i* .

The validity of the instruments comes from the fact that, by construction, the predicted values are not correlated to components of (A_i, B_i, A_i^S) that are not controlled for by Z_i in the last step of the procedure.

Note that identification does not come from non-linearities of the model only. Indeed when running the actual IV regression in step 3 of the procedure we only control for i 's own Z_i , whereas each equilibrium value \hat{H}_j^M is a combination of the whole Z and distances. Identification is thus achieved by using the model to weight distant values of Z and use them as instruments. When we suspect that one of the variables might have direct spillover effects on the productivity of neighboring municipalities, such as access to a river, it is thus important to control for the direct effect of distance to this amenity by directly including it in Z .

Table 1.6: Estimates of spillover parameters for productivity.

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP	TFP	TFP IV	Bias	Bias	Bias IV
main						
λ (Intensity)	0.0401*** (0.00200)	0.0453*** (0.00244)	0.0403*** (0.00253)	0.0815*** (0.00613)	0.0930*** (0.00744)	0.0774*** (0.00788)
ρ (Decay)	-0.503*** (0.0409)	-0.520*** (0.0382)	-0.454*** (0.0490)	-0.539*** (0.0695)	-0.550*** (0.0628)	-0.584** (0.115)
Controls	No	Yes	Yes	No	Yes	Yes
F first stage			612.8			612.8
# of moments			15			15
J stat			5.882			7.327
N	696	696	696	696	696	696

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Agglomeration effects are measured in terms of total workforce, defined as the CES aggregate for labor. "Controls" include the variables in Table 1.A.6 in Appendix. Columns with no first-stage F-stat and overidentification tests are NLS regressions, columns with those statistics are model-based IV regressions. First stage F statistic reports the F-test from regressing \bar{H}^M on its model-based counterpart.

As a first guess, I use the values estimated by Ahlfeldt et al. (2015) and set the TFP parameters to $\lambda^A = 0.07$ and $\rho^A = -0.35$ and the amenities parameters

to $\lambda^B = 0.35$ and $\rho^B = -0.8$ for both the high skilled and low skilled amenity indices. For the skill bias, I simply set both parameters λ^S and ρ^S to zero.

Table 1.A.6 in appendix reports the results of the first stage regressions, where I regress amenities, TFP, skill bias and workplace niceness on exogenous amenities. The included explanatory variables are mean altitude, maximum slope, distance to rivers, and a dummy equal to one if the centroid of the municipality is less than 5km away from a river. For amenities, I also include a dummy variable for listed buildings in the municipality. R-squared are 9% for skill bias, 13% for TFP, 11% and 10% for high and low skill amenities, and 11% and 13% for labor supply shifters. All the F-stats are above 15. Altitude and slope are the main explanatory variables for TFP and skill bias, and they have the expected negative sign. For residential amenities, the listed buildings dummy is the only significant predictor. Existing studies in Europe (Koster et al., 2016; Koster and Rouwendal, 2017; Garcia-López et al., 2018) report that historic amenities are a strong driver of household location choice and sorting.

Table 1.6 shows the results of the naive non-linear least squares and GMM estimates of the agglomeration effects for TFP and skill bias. Regarding TFP, the GMM estimate of the elasticity is $\lambda^A = 0.040$, equal to the OLS estimate up to the third digit. The spatial decay is estimated at $\rho^A = -0.454$, lower than the OLS estimates. The magnitude of the estimated λ^A parameter is in line with the recommended value from Ahlfeldt and Pietrostefani (2019) of 0.04. It is also in line with the between-cities estimates of the effects of density on TFP in France from Combes et al. (2010) (IV estimates on TFP ranging from 0.031 to 0.048 depending on specifications). Skill bias parameters are much higher, with a GMM estimate of $\lambda^S = 0.078$ and $\rho^S = -0.571$.

Similarly, Table 1.7 reports the estimated spillover effects for residential amenities, where the variable generating spillovers is total residential income per

Table 1.7: Estimates of spillover parameters for amenities.

	(1)	(2)	(3)	(4)	(5)	(6)
	B0	B0	B0 IV	B1	B1	B1 IV
main						
λ (Intensity)	0.230*** (0.0165)	0.179*** (0.0196)	0.127 (0.0750)	0.428*** (0.0163)	0.427*** (0.0195)	0.351*** (0.0507)
ρ (Decay)	-0.984*** (0.154)	-1.123*** (0.248)	-1.133 (1.328)	-0.711*** (0.0527)	-0.755*** (0.0587)	-0.682** (0.155)
Controls	No	Yes	Yes	No	Yes	Yes
F first stage			433.8			433.8
# of moments			16			16
J stat			30.48			23.30
N	696	696	696	696	696	696

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Lambda measures agglomeration and tau measures its spatial decay. Spillovers are measured in terms of total income per unit of land. “Controls” include the variables in Table 1.A.6 in Appendix. Columns with no first-stage F-stat and overidentification tests are NLS regressions, columns with those statistics are model-based IV regressions. First stage F statistic reports the F-test from regressing \bar{W}^R on its model-based counterpart.

land unit. For low-skilled residential amenities, the OLS spillover is $\lambda^{B,L} = 0.23$. Adding controls, the effect drops to 0.179. Instrumenting total incomes further reduces the estimated coefficient to 0.127, although it is now imprecisely estimated and not significantly different from zero. Regarding the decay parameter, it increases from -0.984 without controls to -1.123 when introducing control variables, and stays stable when instrumenting. For high-skilled workers, OLS estimates of the spillover effects are 0.428 without controls and 0.427 when introducing control variables, while the GMM estimate is $\lambda^{B,H} = 0.351$. The decay parameter is quite stable to introducing control variables and when instrumenting (resp. 0.755 with and 0.711 without controls, and 0.682 when instrumenting). The strength of spillovers is thus approximately twice as high for high-skilled than for their low-skilled counterpart across specifications, which is in line with previous evidence that high-skilled workers value consumption

amenities more than their low-skilled counterparts (e.g. Couture and Handbury, 2020).

Table 1.8: Variance of amenities.

	(a) Low skilled			(b) High skilled			
	St. Dev.	Correlation		St. Dev.	Correlation		
		Tot.	End.		Tot.	End.	
Total	1.07	1.00	0.67	Total	1.47	1.00	0.82
Endogenous	0.42	0.67	1.00	Endogenous	0.98	0.82	1.00
Residual	0.85	0.93	0.35	Residual	0.87	0.77	0.26

Variance decomposition of the estimated amenities. Total references the amenity index, endogenous is the predicted endogenous amenities based on GMM estimates of the spillover parameters, and residual is the part of amenities that is total minus endogenous. Everything is in logs.

Table 1.8 presents a decomposition of the variance of estimated amenities into estimated endogenous amenities (predicted from equation (1.27) with the GMM estimates of λ and ρ) and residuals. First, we see that high-skilled amenities have a higher variance and are better explained by the estimated endogenous component than low-skilled amenities, consistent with the stronger spillover parameters. Second, in both cases endogenous and residual amenities are positively correlated, as would be expected given the reverse causation between amenities and residential incomes.

In the model simulations of the next section, I set the spillover and decay parameter to their GMM estimates.

1.3.7 Correlation between model-based and observed amenities

In this section, I look at the correlation between the amenities computed above and a set of observed variables, as a way to check the validity of the model spec-

ification. I use the *Base Permanente des Équipements* dataset, a public dataset with the location of a wide range of endogenous amenities, from restaurants to swimming pools and general practitioners. A complete list of the variables used and associated descriptive statistics are reported in Table 1.A.7 in appendix.

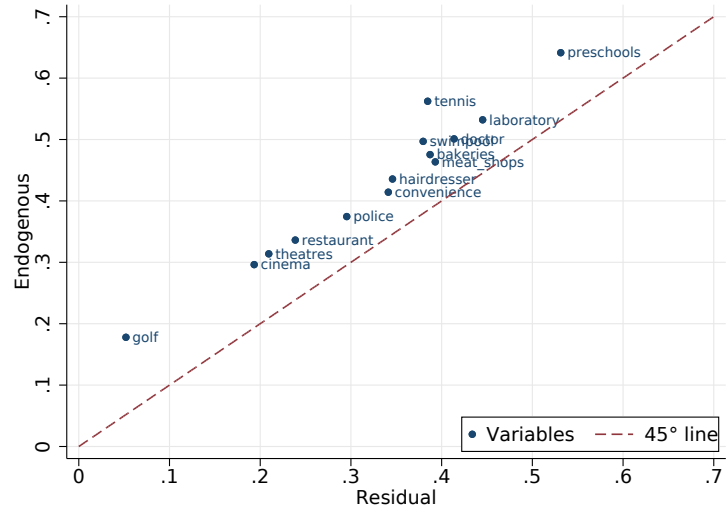
To explore the relationships between observed and model-implied amenities, Figure 1.3 reports raw correlations between observed and theoretical amenities both for high and low-skilled workers. The number of preschools, medical laboratories and doctors are the variables that correlate the most with endogenous amenities, whilst cinemas, restaurants and theatres have the lowest correlation. Consistent with the endogenous nature of these amenities, their correlation is stronger with the estimated endogenous component of amenities (predicted from eq. (1.27) with the GMM parameter estimates from the previous section).

All these observed amenities also correlate positively with residual ("exogenous") amenities. However all the dots lie above the 45° line, indicating that this correlation is systematically weaker than with endogenous amenities. This shows that the model-based endogenous amenities index captures most of the effect of observed amenities. Moreover, it is not surprising to see a positive correlation between the amenities residual and observed amenities, as we expect that high exogenous amenities anchor neighborhoods into high population, high endogenous amenities status.

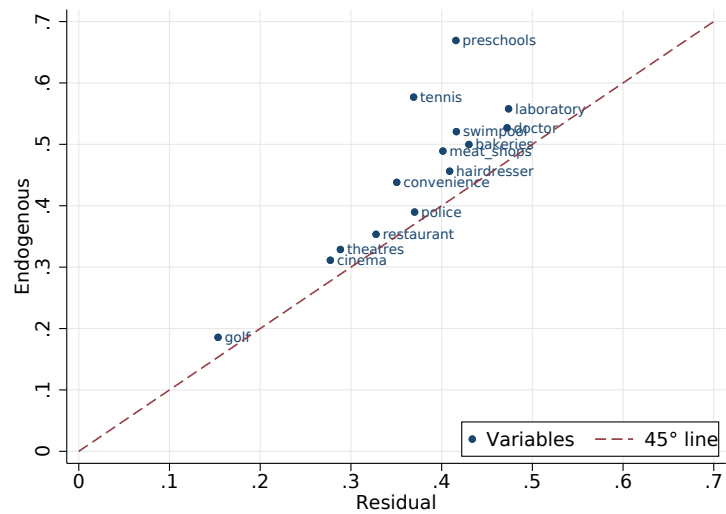
To further explore the relationship between model-based amenities and observed amenities, Table 1.10 reports the results of linear regressions of model-based amenities on observed amenities. Due to the high degree of colinearity between observed amenities, I do not include the whole list of amenities included in Figure 1.3. Instead, I include the number of tennis courts and horse-riding

Figure 1.3: Raw correlations between observed and estimated amenities

(a) Low skilled



(b) High skilled



Note: each dot is an observed amenity. The y axis reads the correlation coefficient between this amenity and the estimated endogenous amenities, while the x axis reads its correlation with the residual (i.e. exogenous) amenities.

clubs to represent sports and outdoors activities, the number of cinemas for consumption amenities, as well as the number of doctors and preschools.⁷

⁷Including the whole set of observed amenities included in Figure 1.3 only raises the R2 in column (2) to 0.61 and the one in column (5) to 0.50.

Table 1.10: Regression of model-implied amenities on observed amenities.

	High Skilled B			Low Skilled B		
	(1)	(2)	(3)	(4)	(5)	(6)
Endo. H-S	1.233*** (37.96)		0.896*** (21.76)			
Endo. L-S				1.709*** (23.81)		1.006*** (11.24)
tennis		1.360*** (8.28)	0.621*** (4.74)		0.538*** (4.06)	0.175 (1.38)
horses		2.186*** (6.30)	1.060*** (3.89)		0.547 (1.96)	0.0189 (0.07)
cinema		0.335** (2.66)	0.0714 (0.73)		0.0814 (0.80)	-0.0454 (-0.48)
doctor		0.0411*** (3.31)	0.0547*** (5.71)		-0.00676 (-0.68)	0.000505 (0.05)
preschools		0.517*** (7.44)	0.0499 (0.86)		0.632*** (11.25)	0.417*** (7.57)
Constant	-15.11*** (-112.37)	-11.09*** (-214.72)	-14.15*** (-96.86)	-12.54*** (-130.93)	-10.95*** (-262.71)	-11.97*** (-121.72)
r2	0.675	0.569	0.744	0.450	0.469	0.551
N	696	696	696	696	696	696

t -statistic in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Regression of model-based amenities on a set of observed endogenous amenities. In columns (1) to (3), the dependent variable is high-skilled model-based amenities. In columns (4) to (6), low-skilled model-based amenities.

The R -squared of the regression of high-skilled amenities on these five observed variables (column (2)) is 0.56, which shows that the estimated high-skilled amenity index correlates strongly with observed amenities. Further, including them in a regression with the estimated high-skilled residential spillover index only raises the model's R -squared from 0.68 to 0.74, indicating that the estimated endogenous component of amenities indeed captures most of the effect of observed endogenous amenities.

For low-skilled workers, R -squared are globally lower but follow the same pattern. Consistent with the lower estimated spillover parameters in the previous section, the regression of low-skilled amenities on observed amenities yields a R -squared of 0.47 (column (5)). Including them in a regression of low-skilled model-based amenities on the estimated low-skilled residential spillovers raises the R^2 from 0.45 to 0.55.

1.4 Simulations

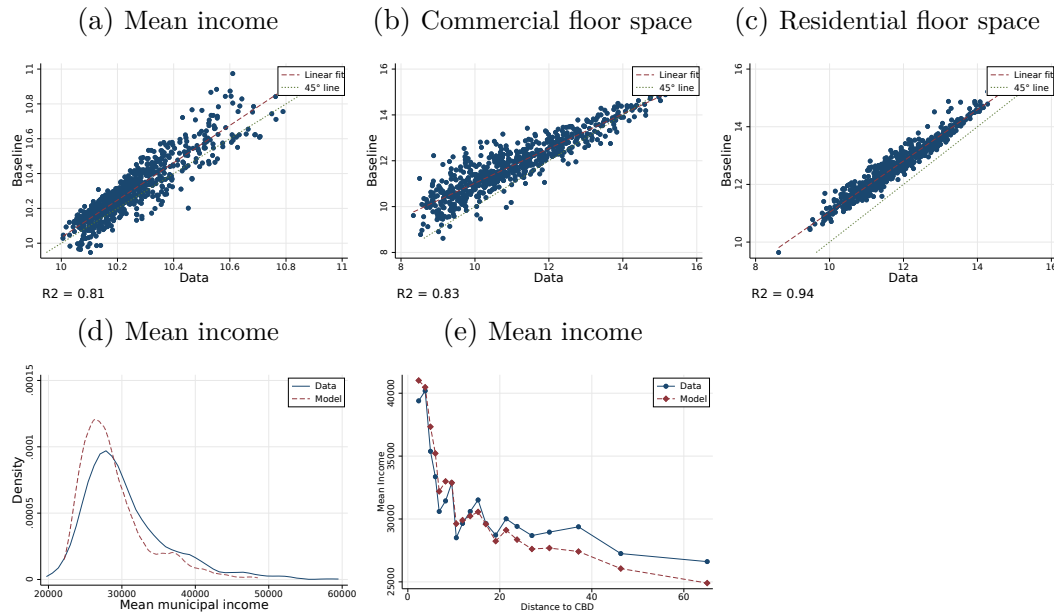
1.4.1 Model fit and overidentification tests

In this section, I report the results of a baseline simulation of the model with the estimated and calibrated parameter values from the previous section.

Simulations are computed using a fixed-point algorithm that reproduces a dynamic setup with myopic workers. With agglomeration effects and spillovers, these types of models are not guaranteed to yield a unique equilibrium. This simulation process thus chooses the equilibrium that is the "closest" to the baseline, in the sense that it is the equilibrium that the economy would reach under the following adjustment process. At each iteration t , taking previous period commute flows as fixed, wages $(w_j^e)^t$ and rents Q_i^t are computed that clear the floor space and labor markets, as per equation (1.22), (1.24) and (1.23). Endogenous amenities and TFPs are computed according to those new rents and wages. A new mass of workers is then computed for each commute using the bilateral choice probabilities. I then update incomes, rents and spillovers again, and the operation is repeated until the repartition of workers stabilizes.⁸

⁸In practice, convergence is declared when the maximum absolute relative deviation between two consecutive iterations of skill flows and workers flow of each type is lower than 10^{-5} , i.e. when $\max\{|(H_{ij}^{Fe})^{t-1} - (H_{ij}^{Fe})^t| / (H_{ij}^{Fe})^t, \quad i, j = \{1, \dots, J\}, F = \{M, R\}, e = \{H, L\}\} < 10^{-5}$.

Figure 1.4: Overidentification checks: data vs. non-targeted variables



Note: Each observation is a municipality. (x axis) vs. model baseline simulations (y axis) for mean income (a), the total floor space of commercial building (b), and the total floor space of residential building (c). Panel (d) reports actual (solid) and predicted (dashed) density of mean incomes across municipalities. Panel (e) reports bin-scatters of actual (solid) and predicted (dashed) mean income as a function of distance to the city center.

In calibrating the model, I do not directly target mean incomes and I do not use the data on floor space. They are therefore good candidates to test the specification of the model.

Although the model perfectly fits total populations, wages and rents conditional on the other observed variables in the model, it is not possible to calibrate the model to perfectly match total incomes and total populations at the same time, i.e. to perfectly predict mean incomes. Instead, the relationship between populations and income is determined by the non-homotheticities in workers preferences, their choice of workplace and the share of high-skilled workers in a given municipality. I find that the model captures mean incomes variations quite well (Figure 1.4 Panel (a), $R^2=.81$), and although the model predicts less spatial disparities than observed, the shape of the distribution of mean incomes between

municipalities (Figure 1.4 Panel (d)) is well captured. Finally, the specification of distance disutility allows to closely replicate the gradient of mean incomes in the city (Figure 1.4 Panel (e)).

Turning to commercial and residential floor space, they are well fitted with squared correlations of respectively 0.83 and 0.94, indicating that the demand functions are well calibrated. In Appendix 1.A.6, I report maps of actual and predicted mean incomes and residential floor space. The model is able to closely replicate the spatial patterns of these variables.

1.4.2 Suburban train network (RER)

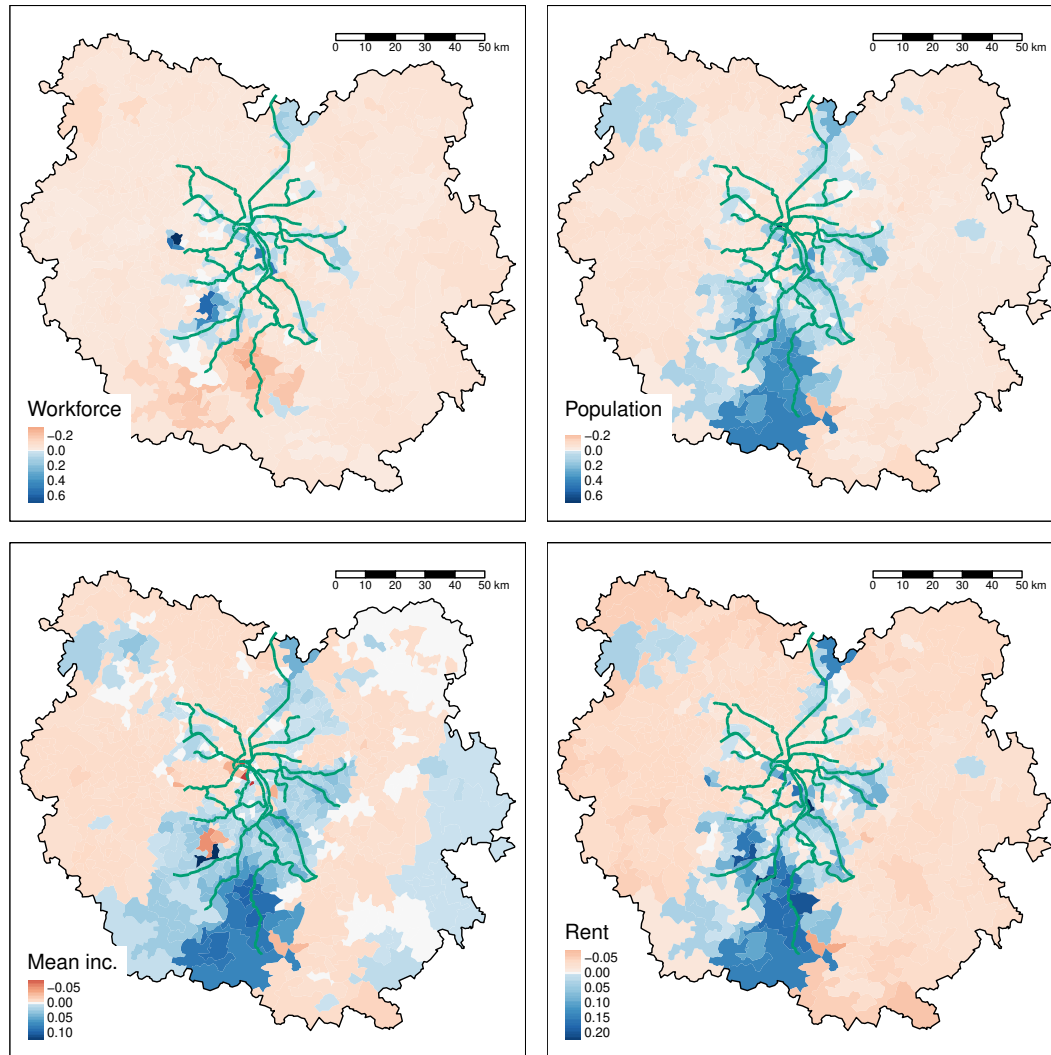
In this section, I look at the effect of the public transport network on the structure of the city by simulating a counterfactual Paris in which suburban trains from the Regional Express Rail (RER) network are removed.

The RER is a suburban rail network made of radial lines connecting Paris to its suburbs. In 1965, a plan to turn the mono-centric area of Paris into a poly-centric region was devised by the French government, that revolved around developing new sub-centers — the *New Towns* — that would house secondary business districts and residential areas. The RER rail system was devised as a set of radial lines that would cross the region to connect those sub-centers to Paris, complemented by a set of new metropolitan highways.

Inaugurated in 1977, the RER network was initially composed of two lines, one crossing the region from north to south and the other one from east to west, and was later extended to four lines, with a fifth one constructed in 2015.

With more than 500 Km of lines, the Regional Express Rail is the backbone of the Parisian transport network. Indeed, Table 1.A.1 in appendix reports summary statistics of travel times by public transport between pairs of municipalities in the Region, with and without allowing the use of the RER. On average, the

Figure 1.5: Contributions of the suburban train (RER) to municipal outcomes.



Note: Maps of the contribution of the RER network to the number of workers (Workforce), the number of residents (Population), average income of residents (Mean inc.) and rents (Rent) in the Paris metropolitan area. Contributions are computed for variable y as $(y_{\text{Baseline}} - y_{\text{NoRER}})/y_{\text{Baseline}}$. Descriptive statistics in table 1.A.2.

RER lowers travel times between all pairs of municipalities in the region by 22%, and travel times to the city center by 20%. Moreover, its effect on travel times is higher for municipalities located between 10 and 60 kilometers from the city

center, because municipalities located further away are not connected to the network while those located closer to the center can use the faster metro lines.

Table 1.11: Effect of the RER network on commute costs to the CBD.

	(1)	(2)	(3)	(4)	(5)	(6)
	Unskil. Pop.	Skil. Pop.	Unskil. Emp.	Skil. Emp.	Rents	Mean Inc.
RER=1	0.0885*** (0.0118)	0.100*** (0.0134)	0.0379*** (0.00965)	0.0417*** (0.00786)	0.0443*** (0.00394)	0.0115*** (0.00174)
Constant	-0.0246*** (0.00578)	0.000346 (0.00656)	-0.0345*** (0.00473)	-0.0299*** (0.00385)	-0.0146*** (0.00193)	0.00252** (0.000851)
Observations	696	696	696	696	696	696
R^2	0.075	0.075	0.022	0.039	0.154	0.059

Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Regressions of the difference in (log) outcome between baseline and no-RER simulations on a dummy equal to one if the municipality was eventually connected to the RER network. Columns (1) and (2) report results on population for low and high skilled workers respectively, columns (3) and (4) on employment, column (5) on rents and column (6) on mean income at the residential location.

General effects of the RER Maps in Figure 1.5 show the current contribution of the RER network to municipal outcomes. Contribution for variable y is measured as $1 - y_{\text{NoRER}}/y_{\text{Baseline}}$, where y_{NoRER} is the result of a simulation of the model with travel times computed by omitting the Regional Express Rail. It appears from these maps that the RER not only has a decentralizing effect on employment, populations, incomes and rents, but that this effect is heterogeneous conditional on distance. The biggest impact on populations and rents is measured for the most southern municipalities of the area, which are connected to the last stops of the D line of the RER, and otherwise poorly served by the rail network.

Quantitatively, Table 1.11 gives the effect of the RER network on the connected and non-connected municipalities in the region. It is computed by regressing the log of the difference between baseline outcomes and outcomes without the RER on a dummy equal to one when the municipality is connected

to the RER. On average, unconnected municipalities get a loss of unskilled population of 2.5%, while connected municipalities get an additional increase of 8.9%. The effect on skilled population is stronger, with an average gain of 10% for connected municipalities. Further, the network have an effect on total incomes and income sorting in the area, with an increase of average incomes of 0.25% for unconnected municipalities and an additional 1.15% for connected ones.

The effect on employment is globally weaker than on populations, with a reduction for unconnected municipalities of 3.5% and 3.0% respectively for low and high-skilled workforce, and respective additional increases of 3.8% and 4.2%. These effects on population and employment have a substantial impact on the market for floor space, with a rent decrease of 1.5% on average in unconnected municipalities and an additional increase of 4.4% in connected municipalities.

Table 1.12: Aggregate effects of the RER network on incomes in the region.

	Mean	Total SD	Between SD	(%)	C-P
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	31129.84	20903.03	3544.28	16.96	10603.74
Effect (%)	0.09	-0.02	-1.93	-1.91	-3.68

Column 1 is the average income over all workers. Column 2 is the total standard deviation of income over individual workers. Column 3 is the between-municipality standard deviation. Column 4 is the ratio between the two times 100. Column 5 is mean income in the center minus mean income 10 to 15 kilometers away from the center.

Sorting The impact of the RER network on workers location translates into marked effects on income disparities, as reported in Table 1.12. First, average income in the area increases by 0.1% while the total standard deviation of incomes drop by 0.02, pointing to a small reduction of income inequalities. Turning to spatial inequalities, the between-municipalities SD drops by 1.93%. Further, the income premium of Paris with respects to its suburbs (10 to 15

kilometers away from the CBD) drops by 3.68%, which shows that the RER network lowers income inequalities between the center and the periphery.

Table 1.13: Welfare of high and low-skill workers, with and without the Regional Express Rail.

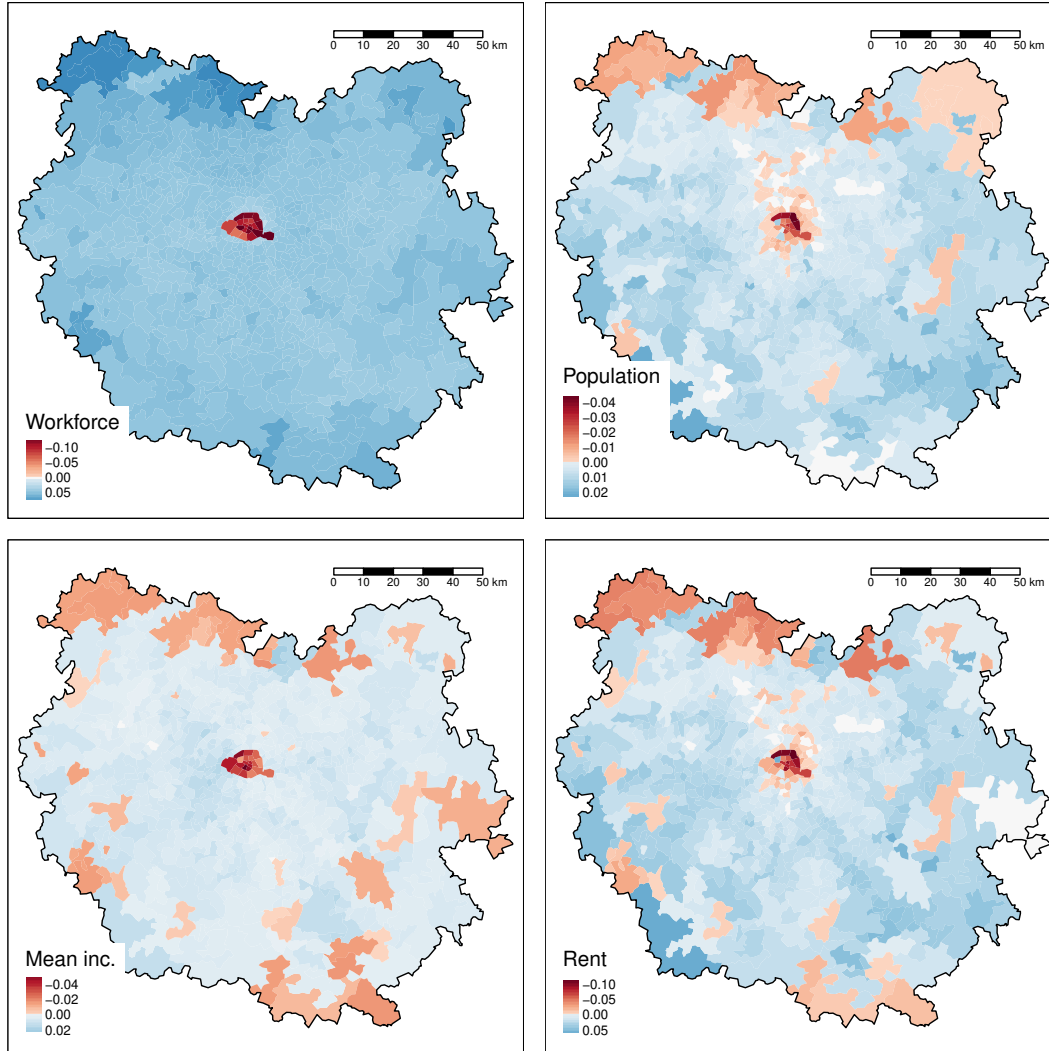
	Low skill	High skill	Ratio
Baseline	109.86	594.01	5.41
Counterfactual	106.22	578.79	5.45
Effect (%)	3.32	2.56	-0.78

Redistribution Finally, I compute the contribution of the Regional Express Rail to workers welfare and welfare inequality. Although the effect of the RER on location choices is stronger for high-skilled than low-skilled workers, its total welfare effect is higher for the latter group. As a result, it leads to a decrease in welfare inequalities. Indeed, the network accounts for 3.32% of the total welfare of low-skilled workers and 2.56% of that of high-skilled workers, thus reducing welfare inequalities by 0.78%.

Comparison with reduced-form results Mayer and Trevien (2017) evaluate the effect of the introduction of the regional rail system (RER) between 1970 and 1990 in the Paris area. The present simulation does not exactly replicate their setting, as my counterfactual simulation uses the current network without the RER, not the network as it was in 1970. Further, I study re-organization effects in a closed city when their measure takes into account both growth and relocation. They measure an effect of 8.8% on employment, and a positive but unstable effect on populations, stronger for high-skilled workers. Overall, the model-implied effects above are in line with the estimates they report, and in line with the broader literature on the effects of the RER network (e.g. Garcia-López et al., 2017).

1.4.3 Banning cars from Paris

Figure 1.6: Effects of banning cars in Paris.



Note: Maps of the effects of banning commuting by cars to and from Paris on the number of workers (HM), the number of residents (HR), average income of residents (meaninc) and rents (rent) in the Paris metropolitan area. Inelastic floor space supply. Descriptive statistics in table 1.A.2.

In this section, I turn to counterfactual simulations where commuting by car is banned when commuting from or to the city of Paris, so that all commuters

within Paris, between Paris and the suburbs or vice-versa have to take public transports for commuting.

In 2017, following engagements taken as part of the 2015 COP21 agreements, the Council of Paris signed a document planning to ban thermal vehicles from its streets, with a plan of zero diesel cars by 2024 and zero thermal vehicles by 2030.⁹ This announcement has been a source of debate in the region, with some opponents pointing out that the measure, given the current costs of electric vehicles, might penalize suburban workers. To assess this statement, I consider the somewhat more excessive situation of a complete ban on cars, thermal or not, within the city of Paris. This is implemented by setting the probability to travel by car to zero for every trip from or to the city of Paris.

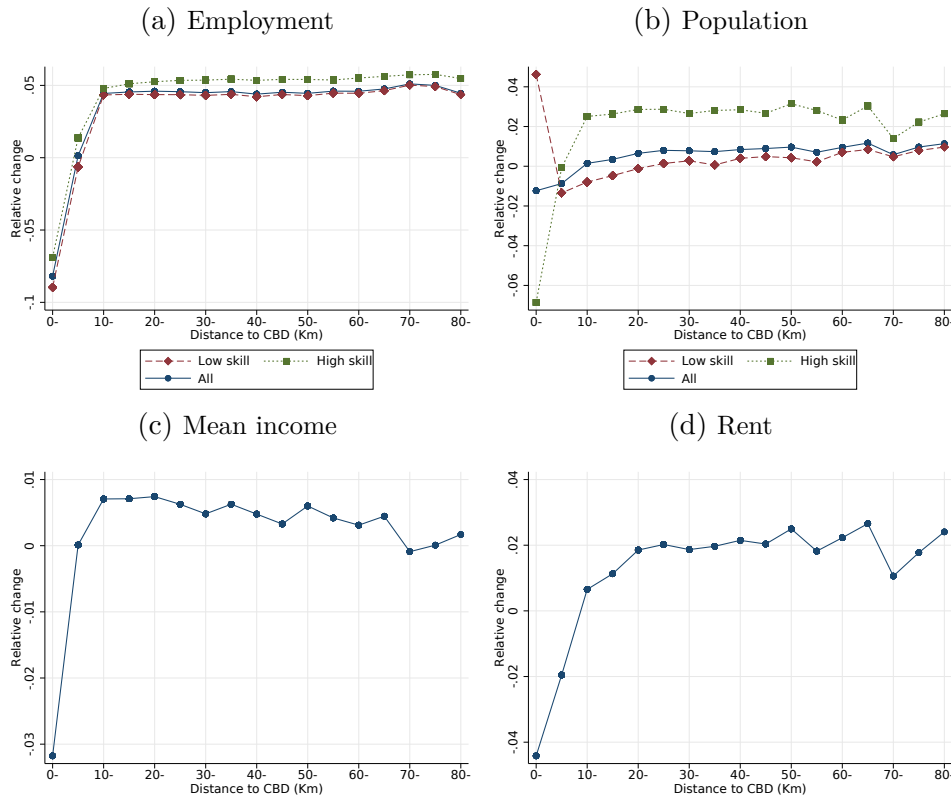
I focus on short-term effects where residential and commercial floor space are fixed to their baseline levels. Section 1.A.5 in appendix shows the results from an alternative simulation where floor space is elastic and landlords are allowed to convert between commercial and residential floor space.

Figure 1.6 shows maps of the effect of a car ban on the Grand Paris region. Contrary to the predictions of a monocentric model, the model predicts that increasing the cost of accessing the city center would penalize the center itself, as firms and workers relocate outside of the city walls. This leads to a decrease in rents in the center, allowing for lower income residents to relocate within the city.

General effects Figure 1.7 Panel (a) shows the effect of the car ban on employment, population, income and rent gradients. The center of Paris experiences a loss in employment of 7%, that relocate 10km away from the center. Regarding

⁹ *Plan Climat*, available in French and English at <https://www.paris.fr/pages/nouveau-plan-climat-500-mesures-pour-la-ville-de-paris-5252>, accessed on August 21, 2020.

Figure 1.7: Effect of banning cars in Paris.



Note: Average effect of banning cars in Paris on employment, population, mean income and the between-municipality coefficient of variation of mean incomes in bins of 5km from the city center (first district of Paris). Inelastic floor space supply.

populations, the center experiences a loss in high-skilled residents of 6%. For low-skilled workers, the pattern is u-shaped: their number increases by 4% in the center, decreases in the close suburbs and increases again in the more remote locations of the area.

Sorting Turning to income sorting, the outflow of high skilled workers and the lower rents in the center translate into a decrease of the income premium of the city, as incomes within 5 kilometers fall by 3%, and incomes in the suburbs rise by 0.5%. This effect corresponds to a drop of the mean income premium of the center relative to the close suburbs (from 10 to 15 kilometers) of €1500.

Table 1.14: Aggregate effects of banning in Paris on incomes in the region.

	Mean	Total SD	Between SD	(%)	C-P
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	31093.20	20784.18	3538.56	17.03	8727.20
Effect (%)	-0.21	-0.55	1.77	2.33	-14.66

Column 1 is the average income over all workers. Column 2 is the total standard deviation of income over individual workers. Column 3 is the between-municipality standard deviation. Column 4 is the ratio between the two times 100. Column 5 is mean income in the center minus mean income 10 to 15 kilometers away from the center.

This amounts to a 14.7% reduction from the baseline income gap of €10227. In terms of total spatial income heterogeneity, this does however translate into an increase of 1.8% of the between-municipality standard deviation of mean incomes. Because the total standard deviation of mean incomes decreases, relative segregation (measured as the ratio between the two) increases by 2.3%.

Table 1.15: Welfare of high and low-skill workers, effects of banning cars in the city center.

	Low skill	High skill	Ratio
Baseline	109.86	594.01	5.41
Counterfactual	107.13	576.46	5.38
Effect (%)	-2.49	-2.95	-0.48

Welfare Finally, the policy creates a welfare loss of 2.49% for low-skilled workers and 2.95% for high-skilled workers, slightly reducing welfare inequalities. These effects are quite substantial, as they are roughly of the same size as the positive effects of the Regional Express Rail.

Increasing amenities in the center It should be noted, however, that these estimates do not take into account the direct effects of banning cars on local amenities in the center in terms of air quality improvement, noise reduction and alternative uses of streets — e.g. terraces. Predicting the magnitude of these

effects is challenging, as we lack data on similar measures that would allow to estimate the elasticity of local residential amenities to banning cars from the city.

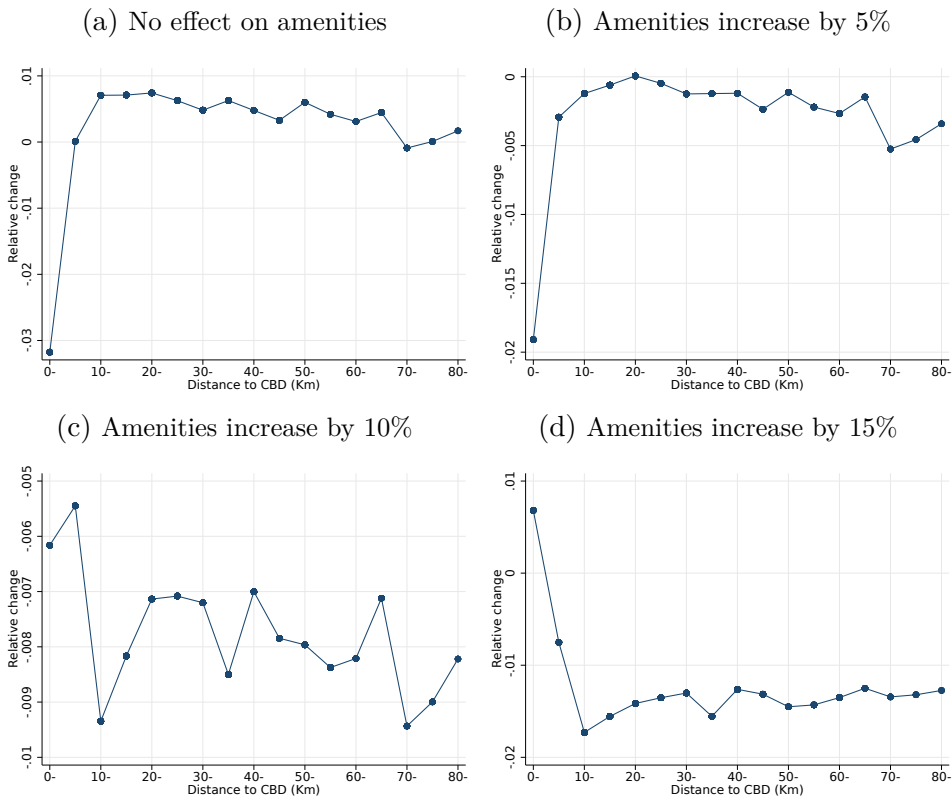
Therefore, I assess the potential importance of these effects by running alternative simulations where I artificially increase exogenous amenities in the city by 5%, 10% and 15%. In these simulations, I assume that the effects of the policy is proportional to the baseline valuation of residential amenities in the center, so that the relative increase in amenity valuation is identical for high and low-skilled workers. Further, like in the baseline treatment where exogenous amenities stay constant, endogenous amenities still adjust according to the spillover equations (1.27).

Table 1.16: Welfare of high and low-skill workers, effects of banning cars in Paris. Alternative assumptions on the effects of the policy on amenities in the city.

	Low skill	High skill	Ratio
No effect on amenities			
Baseline	109.86	594.01	5.41
Counterfactual	107.13	576.46	5.38
Effect (%)	-2.49	-2.95	-0.48
Amenities increase by 5%			
Baseline	109.86	594.01	5.41
Counterfactual	108.33	583.98	5.39
Effect (%)	-1.40	-1.69	-0.30
Amenities increase by 10%			
Baseline	109.86	594.01	5.41
Counterfactual	109.47	591.41	5.40
Effect (%)	-0.36	-0.44	-0.08
Amenities increase by 15%			
Baseline	109.86	594.01	5.41
Counterfactual	110.56	598.77	5.42
Effect (%)	0.63	0.80	0.17

In Table 1.16, I report the welfare effects of banning cars in Paris under those three alternative assumptions on the effects of the policy on residential amenities in the city. It would take an increase of exogenous amenities comprised between 10% and 15% to reverse the total welfare effect of the policy and make it positive. At a 15% increase in amenities, the welfare effect of the policy on low-skilled workers is 0.63% and the effect on high-skilled workers is 0.80%. As a result, when the welfare effects of the policy become positive, its effects on inequalities are reversed and it benefits more high-skilled workers.

Figure 1.8: Effect of banning cars in Paris on the income gradient in the region. Alternative assumptions on the effects of the policy on amenities in the city.



Note: Average effect of banning cars in Paris on mean income in bins of 5km from the city center (first district of Paris), under alternative assumptions on the magnitude of the increase in amenities in the city due to the policy. Inelastic floor space supply.

Turning to spatial inequalities, a 10% increase in amenities is enough to reverse the effects of the policy. As documented in Panel (c) of Figure 1.8, at that point effect of the policy on the income gradient is almost zero. Further, for a higher increase in amenities the mean income premium of the center over the suburbs increases substantially. For a 15% increase in amenities, mean income increases by 0.5% in the center and decreases by 1.5% in the periphery (10 kilometers away). As reported in Table 1.A.5 in appendix, this corresponds to a 7.8% increase in the income gap between the center and the periphery. Although inequalities between the center and the periphery increase, segregation as a whole drops by 2.77%. This is because when richer workers flow in or out of the inner city, they locate in high incomes-high amenity suburban municipalities. When they move back into the center following an increase in amenities, the richest suburban locations become poorer while the poorest ones stay stable, reducing spatial inequalities.

Plausible values for the increase in amenities To better inform the plausible effects of the policy, I turn to back of the envelope calculations of the potential increase in amenities due to the reduction in air pollution, using existing estimates from the literature.

First, Chay and Greenstone (2005) reports an elasticity of house value to suspended particulates between 0.2% and 0.35%, while official estimates from the City of Paris state that 35% of the suspended particulates emissions in the city come from road traffic. Extrapolating from the estimates in Chay and Greenstone (2005), we should anticipate a 7% to 12% in house values.

Similarly, Sullivan (2016) find a semi-elasticity of house values to NO₂ of 0.3%. The City of Paris estimates that 60% of the baseline concentration in the

city of $40\mu\text{g}/\text{m}^3$ comes from road traffic. Applying the estimate from Sullivan (2016), we would get a 6% increase in house value from reduced pollution.

Looking at the results of model simulations, this 6% to 12% increase in house values would necessitate a 5% to 10% increase in amenities. If in the upper part of this range, the reduction in pollution alone would therefore put the policy in a regime where it has no impact on spatial income inequalities at large (-0.25%) and close to no impact on inequalities between the center and the periphery (0.33%). Further, the negative welfare effects would be moderate, and of comparable size for low skilled (-0.36%) and high skilled workers (-0.44%).

1.5 Conclusion

In this chapter, I use an equilibrium model of a metropolitan area to evaluate the impact of transportation infrastructures on spatial disparities within cities. Calibrated on the Paris region, the model is able to closely replicate the spatial repartition of economic activities and the income gradient in the city. Further, simulated effects of public transports on local employment and population are in line with existing reduced-form results.

Simulating away the Regional Express Rail, the model shows that it has sizable effects on income sorting between the city and its suburbs, and reduces the total income inequalities in the area. Further, it does bring a higher welfare gain to low-skilled workers than high-skilled workers, reducing welfare inequalities. On the other hand, looking at an increase in travel time costs through banning cars in the city I find a sizable reduction in spatial inequalities between the city and its suburbs, at the cost of a total welfare loss for both skilled and unskilled workers.

The total welfare loss of banning cars is of a similar magnitude to the welfare gains from the Regional Express Rail, a very important transportation infrastructure. These effects depend however on the direct amenity gains in the city center from the policy. It would require a more than 10% increase in amenities in Paris from pollution reduction and regained floor space for the policy to break even and start having a positive welfare effect, at which point it would start increasing segregation. Back of the envelope calculations based on estimated effects of pollution on housing values suggest that the policy should be close to this break even point. As these amenity effects are determinant in the total effect of the policy, further work should quantify them.

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1.A Additional results

1.A.1 Regional Express Rail

Table 1.A.1: Travel times in minutes, with and without the RER network.

Dist. to center (km)	To the whole region				To the city center		
	RER	No RER	Dif (%)	Con.(%)	RER	No RER	Dif (%)
0-	94.67	111.29	18.83	23.94	39.67	41.39	5.16
5-	108.71	131.16	21.33	26.32	57.46	66.12	16.50
10-	117.28	144.60	23.54	30.11	67.09	80.07	20.98
15-	123.99	153.98	25.04	32.95	73.28	94.95	32.09
20-	132.44	160.57	22.02	31.22	82.69	103.12	25.66
25-	144.52	178.59	23.55	33.43	93.74	117.73	26.78
30-	152.99	190.51	25.38	39.68	100.49	124.28	24.69
35-	154.29	185.83	20.48	26.69	102.67	119.15	16.28
40-	165.80	202.63	22.26	43.27	112.26	130.47	15.55
45-	173.98	215.38	22.69	50.27	118.83	142.74	16.58
50-	188.50	220.03	16.44	23.77	131.79	140.92	6.17
55-	184.25	222.37	20.44	28.27	130.00	142.52	9.35
60-	179.69	235.56	28.57	52.35	121.19	150.67	19.57
65-	206.64	226.41	9.63	16.45	145.95	145.47	-0.22
70-	226.19	249.21	10.28	16.82	164.07	165.85	0.89
75-	231.49	254.32	9.13	15.72	171.35	171.45	0.06
Total	138.52	168.61	22.11	31.19	86.18	102.34	19.63

Average travel times using public transports, in minutes. Each row is a distance bin (in km) to the city center. First four columns report the travel time toward the whole area, originating from a given bin. RER reports travel times with the network, “No RER” travel times without the network, and “Dif.(%)” the relative difference between the two. “Con.(%)” is the relative difference for the restricted sample of commutes where either the origin or destination municipality has a RER stop. Three last columns report the travel time to the city center, originating from a given bin.

Table 1.A.2: Effects of the Regional Express Rail on municipalities

	Mean	S.D.	Min.	Q1	Q2	Max.
Mean income	0.0051	0.0197	-0.0931	-0.0050	0.0107	0.1303
Unskilled population	-0.0111	0.1052	-0.2155	-0.0671	0.0118	0.8484
Skilled population	0.0138	0.1248	-0.3111	-0.0610	0.0609	0.6113
Unskilled employment	-0.0306	0.0816	-0.3149	-0.0555	-0.0239	0.7959
Rent	-0.0051	0.0457	-0.0929	-0.0326	0.0062	0.2471

Descriptive statistics of the contribution of the RER network to municipal outcomes.
Each observation is a municipality in the Paris region. $N = 696$.

1.A.2 Effects of the whole public transport network

Table 1.A.3: Welfare of high and low-skill workers, with and without public transports.

	Low skill	High skill	Ratio
Baseline	109.86	594.01	5.41
Counterfactual	85.40	465.62	5.45
Effect (%)	22.27	21.61	-0.84

Table 1.A.4: Aggregate effects the transport network on incomes in the Paris region.

	Mean	Total SD	Between SD	(%)	C-P
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	30945.86	20460.62	3555.16	17.38	8976.88
Effect (%)	0.68	2.10	-2.24	-4.44	12.22

Column 1 is the average income over all workers. Column 2 is the total standard deviation of income over individual workers. Column 3 is the between-municipality standard deviation. Column 4 is the ratio between the two times 100. Column 5 is mean income in the center minus mean income 10 to 15 kilometers away from the center.

1.A.3 Banning cars

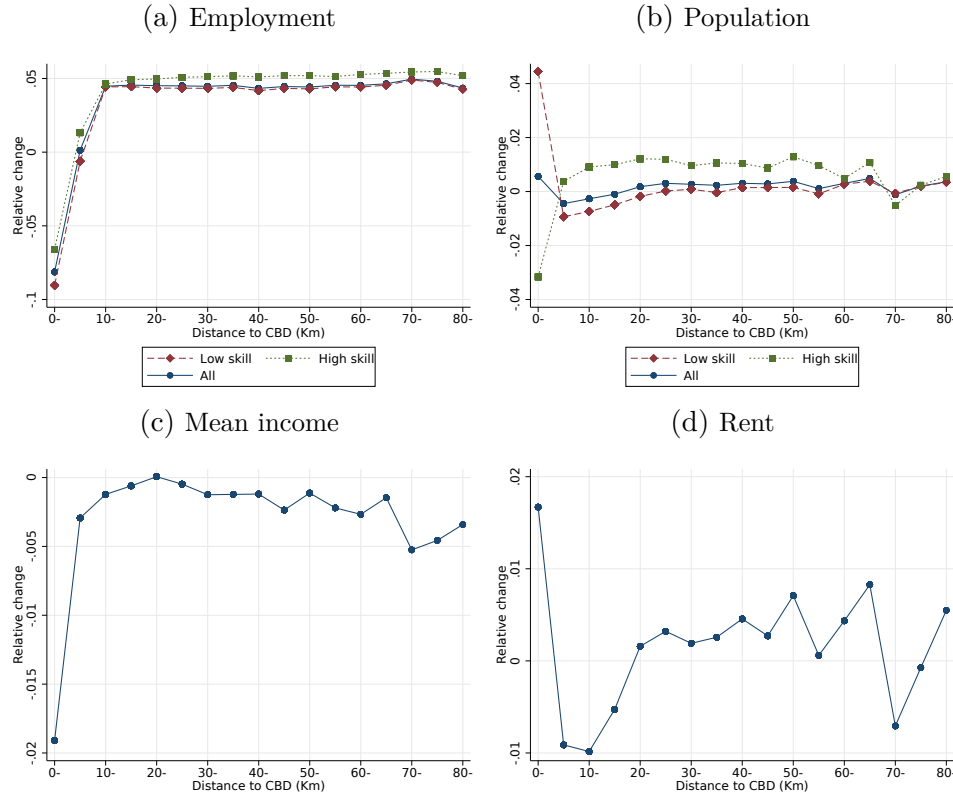
Table 1.A.5: Aggregate effects of banning cars from Paris.

	Mean	Total SD	Between SD	(%)	C-P
No effect on amenities					
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	31093.20	20784.18	3538.56	17.03	8727.20
Effect (%)	-0.21	-0.55	1.77	2.33	-14.66
Amenities increase by 5%					
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	31025.42	20718.69	3481.36	16.80	9491.11
Effect (%)	-0.43	-0.86	0.12	0.99	-7.19
Amenities increase by 10%					
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	30966.18	20659.48	3428.68	16.60	10260.20
Effect (%)	-0.62	-1.15	-1.39	-0.25	0.33
Amenities increase by 15%					
Baseline	31158.68	20899.29	3477.11	16.64	10226.89
Counterfactual	30914.19	20604.64	3380.69	16.41	11025.90
Effect (%)	-0.78	-1.41	-2.77	-1.38	7.81

Column 1 is the average income over all workers. Column 2 is the total standard deviation of income over individual workers. Column 3 is the between-municipality standard deviation. Column 4 is the ratio between the two times 100. Column 5 is mean income in the center minus mean income 10 to 15 kilometers away from the center.

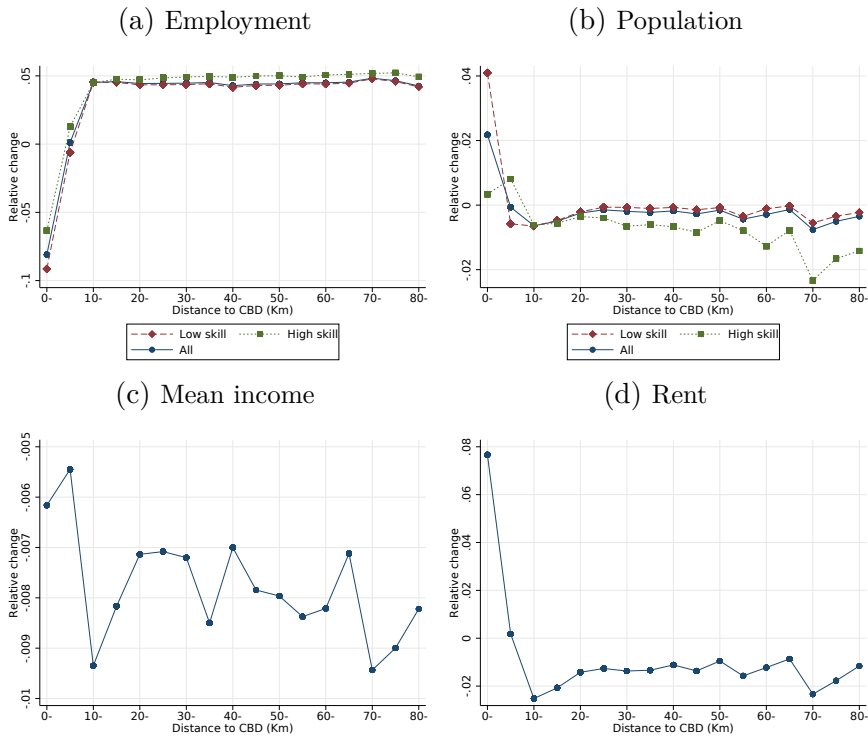
1.A.4 Banning cars: gradients with amenity gains

Figure 1.A.1: Effect of banning cars in Paris, 5% amenity increase in the city.



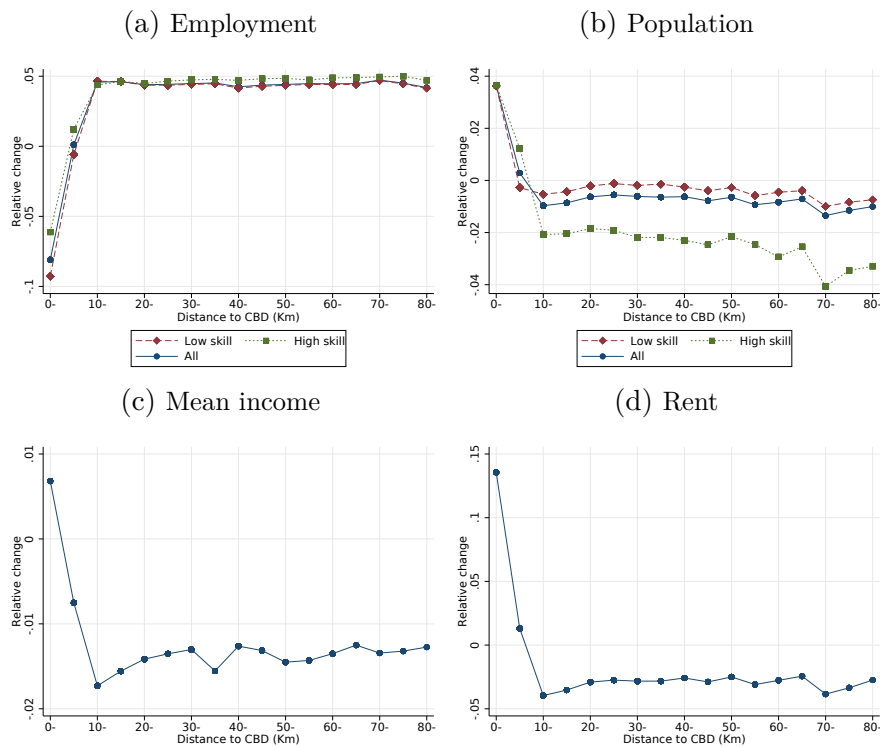
Note: Average effect of banning cars in Paris on employment, population, mean incomes and the between-city coefficient of variation of mean incomes, in bins of 5km from the city center (first district of Paris). Inelastic floor space supply.

Figure 1.A.2: Effect of banning cars in Paris, 10% amenity increase in the city.



Note: Average effect of banning cars in Paris on employment, population, mean incomes and the between-city coefficient of variation of mean incomes, in bins of 5km from the city center (first district of Paris). Inelastic floor space supply.

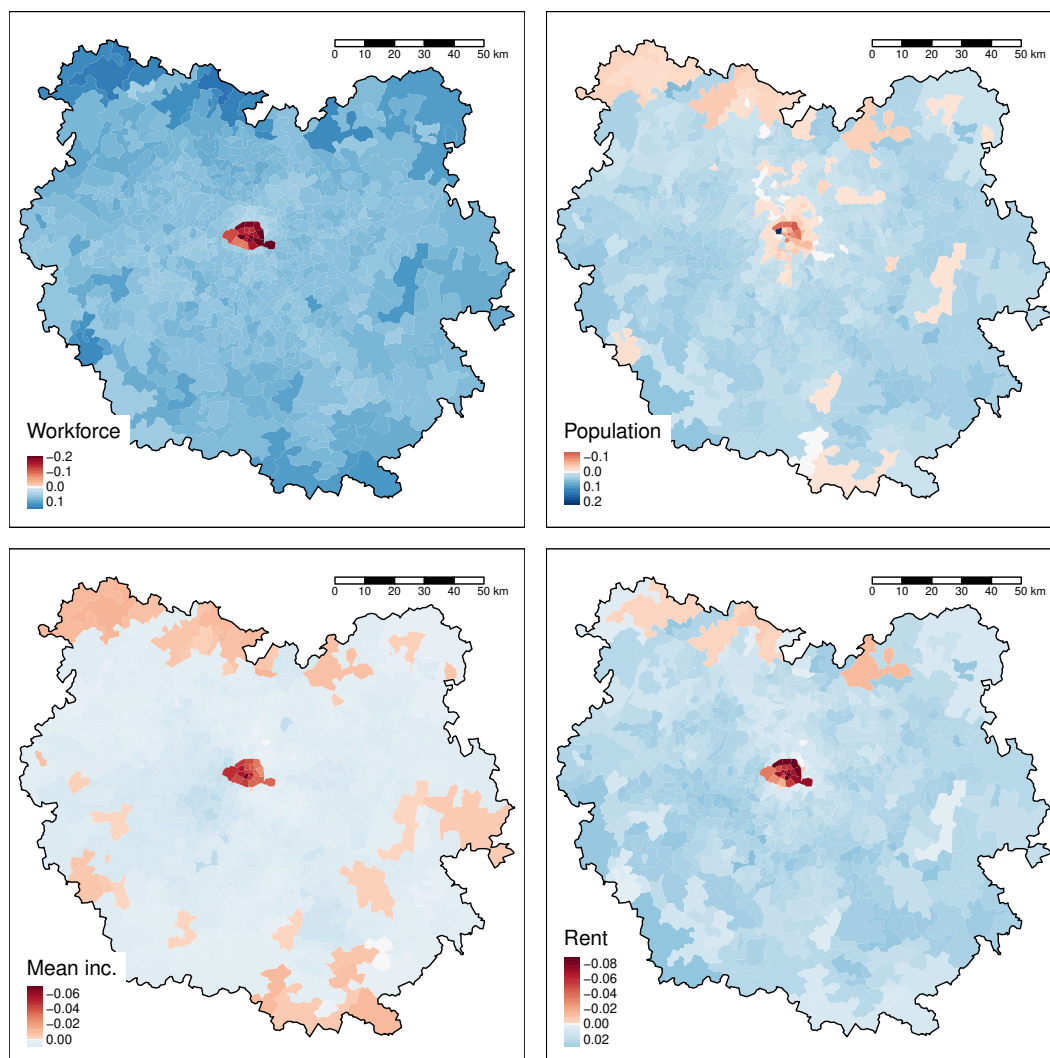
Figure 1.A.3: Effect of banning cars in Paris, 15% amenity increase in the city.



Note: Average effect of banning cars in Paris on employment, population, mean incomes and the between-city coefficient of variation of mean incomes, in bins of 5km from the city center (first district of Paris). Inelastic floor space supply.

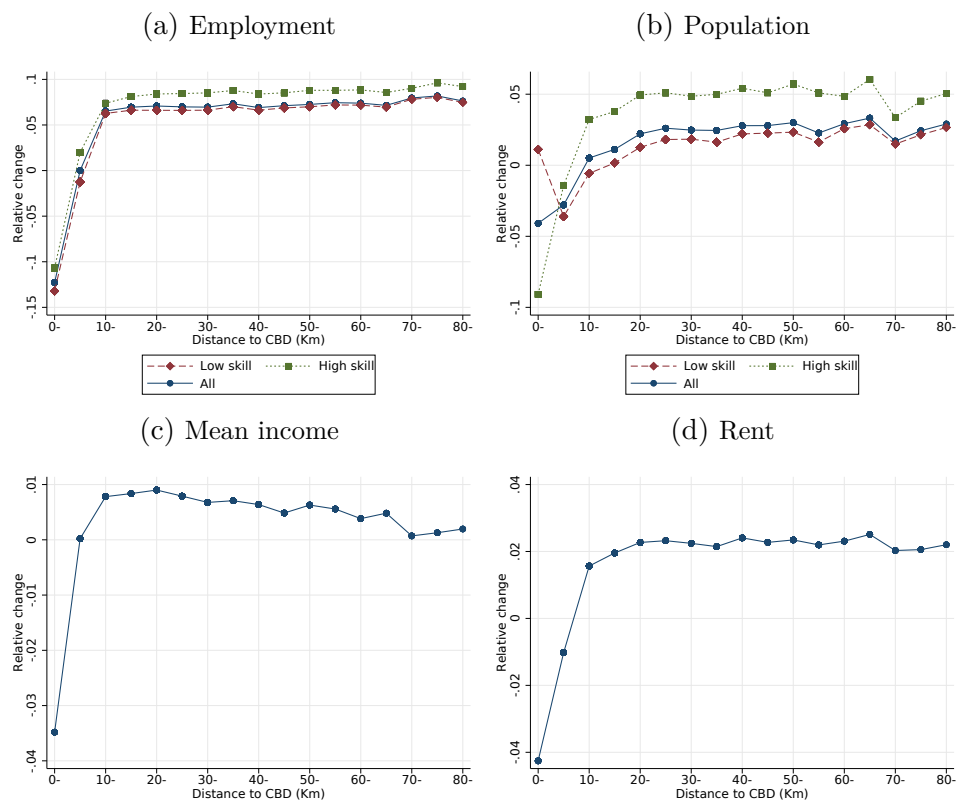
1.A.5 Banning cars: elastic floor space supply

Figure 1.A.4: Effects of banning cars in Paris.



Note: Maps of the effects of banning commuting by cars to and from Paris on the number of workers (HM), the number of residents (HR), average income of residents (meaninc) and rents (rent) in the Paris metropolitan area. Elastic floor space supply.

Figure 1.A.5: Effect of banning cars in Paris.



Note: Average effect of banning cars in Paris on employment, population, mean incomes and the between-city coefficient of variation of mean incomes, in bins of 5km from the city center (first district of Paris). Elastic floor space supply.

1.A.6 Baseline maps

Figure 1.A.6: Mean income. Actual (left) vs predicted (right)

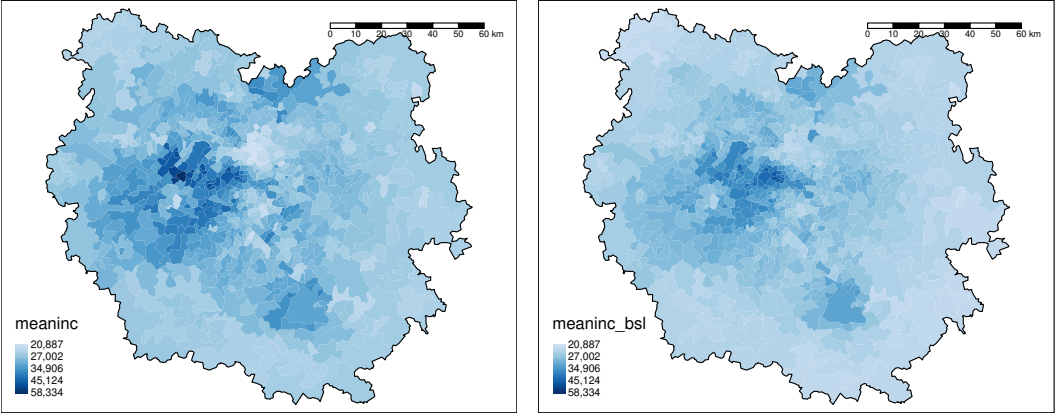
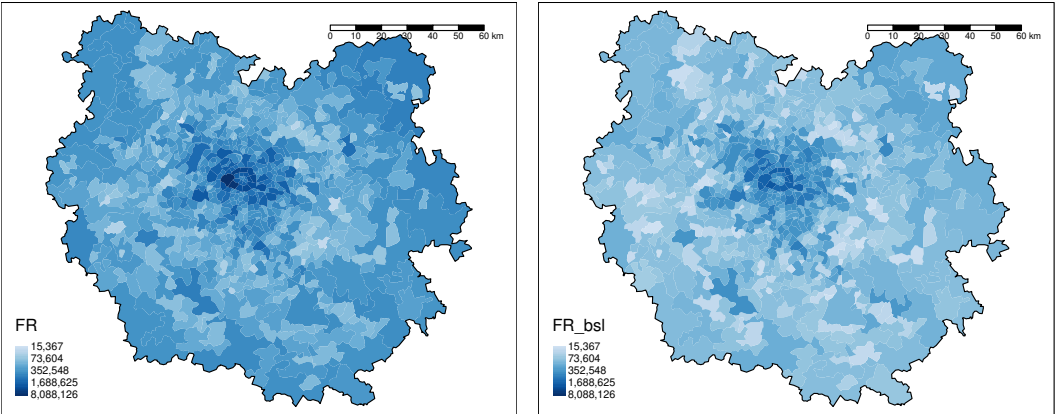


Figure 1.A.7: Residential floor space. Actual (left) vs predicted (right)



1.A.7 Model based IV

Table 1.A.6: Decomposition of fundamentals.

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP	Skill bias	B (s.)	B (u.)	T (s.)	T (u.)
Mean altitude (log)	-0.0930*** (-4.68)	-0.162** (-3.01)	-0.183 (-1.52)	0.00874 (0.07)	-0.573*** (-3.98)	-0.510*** (-3.96)
Maximum slope (log)	-0.0143*** (-5.41)	-0.0413*** (-5.78)	-0.0161 (-1.00)	0.0362* (2.33)	-0.0444* (-2.31)	-0.0346* (-2.02)
Distance to river (log)	0.0119 (1.40)	0.0305 (1.33)	-0.0243 (-0.47)	-0.0114 (-0.23)	0.0429 (0.70)	0.0777 (1.41)
Distance to river < 5km	0.0440* (2.21)	0.0789 (1.47)	0.202 (1.67)	0.0777 (0.66)	0.234 (1.62)	0.264* (2.04)
Listed building dummy			0.597*** (8.11)	0.602*** (8.44)	0.544*** (6.20)	0.590*** (7.53)
Constant	10.58*** (122.07)	0.351 (1.50)	-2.646*** (-5.01)	-3.901*** (-7.62)	2.269*** (3.59)	1.856** (3.29)
r2_within	0.134	0.0889	0.117	0.102	0.116	0.127
F	26.70	16.86	18.26	15.75	18.08	20.06
N	696	696	696	696	696	696

Regression of model fundamentals on exogenous variables. Predicted values from these regressions are used as inputs for the model simulation that generates instruments for incomes and workforce.

Table 1.A.7: Observed amenities

	count	mean	sd	min	max
restaurant	696	14.79053	59.61473	0	766.6667
convenience	696	1.766946	5.252166	0	57.29167
theatres	696	.1270503	.5421777	0	7.070707
cinema	696	.0956781	.3891422	0	6.976744
meat_shops	696	.8831948	2.166097	0	24.65278
bakeries	696	1.915192	4.725206	0	40.40404
preschools	696	.6877911	1.008322	0	7.142857
hairdresser	696	3.530352	9.460522	0	111.4583
doctor	696	2.630785	5.836409	0	49.15966
laboratory	696	.2067682	.4275947	0	3.669725
police	696	.067342	.183323	0	1.834862
tennis	696	.2408132	.3004812	0	2.857143
golf	696	.0183569	.0662338	0	.6944444
hiking	696	.0154199	.0560326	0	.4385965
horses	696	.0516236	.1067405	0	1.587302
swimpool	696	.1071565	.2320357	0	2.020202

Description of observed amenities, in number per squared kilometer. Observation is a municipality. N=696.

1.B Proofs

Lemma 1.B.1. Conditional on strictly positive populations, skill flows and TFPs $\{(H_{ij}), (H_{ij}^M), (A_i)\}$, there is a strictly positive lower bound and a finite upper bound on the vector (Q_i^*) that clears the land and labor markets.

Proof. We start by showing that they are bounded from below. Multiply floor space demand by rents to define for all i

$$\tilde{F}_i^d(Q) = Q_i F_i^d = \beta W_i + (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha} w_i H_i^M$$

where $w_i = w_i(Q_i) = \tilde{A}_i Q_i^{-\tilde{\alpha}}$ as per equation (1.22). Then equilibrium rents Q^* solve

$$G(Q^*) \equiv \ln(\tilde{F}^d(Q^*)) - \ln(L(Q^*)^{1+\mu}) = 0$$

Differentiating G_i while keeping populations constant, we get.

$$\begin{aligned} \frac{\partial G_i}{\partial \ln(Q_i)} &= -(1 + \mu) - \frac{1}{F_i^d} \left(\tilde{\alpha} \beta w_i H_{ii}^M - (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha}^2 w_i H_i^M \right) < -\mu < 0 \\ \frac{\partial G_i}{\partial \ln w_j} &= \frac{\beta w_j H_{ij}^M}{F_i^d} > 0, \quad j \neq i. \end{aligned}$$

Thus by implicit differentiation the solution of the one variable, one equation $G_i(Q_i) = 0$ is strictly increasing in $w_j > 0$, $j \neq i$. Thus, $Q_i^* > Q_i^-$ for all i , where Q_i^- solves

$$G_i^-(Q_i) \equiv \ln \left[\beta w_i H_{ii}^M + (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha} w_i H_i^M \right] - \ln \left[\tilde{L}_i Q_i^{1+\mu} \right] = 0.$$

Further, G_i^- is strictly decreasing on $(0, +\infty)$, with $\lim_{Q_i \rightarrow 0} G_i^- = +\infty$ and $\lim_{Q_i \rightarrow \infty} G_i^- = -\infty$. Therefore, Q_i^- exists, is finite and is strictly positive.

Now because $w_i(Q_i)$ is a strictly decreasing function of Q_i , this means that for all i , $w_i^* < w_i^+ \equiv w_i(Q_i^-)$. Thus, by the same argument as before $Q_i^* < Q_i^+$, where Q_i^+ is the unique, positive and bounded solution of

$$G_i^+(Q_i) \equiv \ln \left[\beta \sum_{j \neq i} w_j^+ H_{ij}^M + \beta w_i H_{ii}^M + (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha} w_i H_i^M \right] - \ln \left[\tilde{L}_i Q_i^{1+\mu} \right] = 0.$$

□

Lemma 1.B.2. Rents (Q_i^*) that clear the housing and labor markets are bounded over the set of feasible populations $\mathcal{H} = \{(H_{ij}) \in \mathbb{R}^{J \times J} \mid H_{ij} \geq 0, \sum_{ij} H_{ij} \leq \bar{H}\}$.

Proof. We show that there is a population vector maximizing Q_i^+ . Implicitly differentiating w_j^+ w.r.t. populations, we get

$$\begin{aligned} \frac{\partial w_j^+}{\partial \ln H_{jj}^M} &= -\tilde{\alpha} \frac{\beta w_j^- H_{jj}^M + \tilde{\alpha} w_j^+ H_{jj}^M}{(1 + \mu + \tilde{\alpha}) \left[\beta w_j^- H_{jj}^M + \tilde{\alpha} w_j^+ H_{jj}^M \right] + \mu(1 - \beta) \underline{f} H_j^R Q_j^-} \in \left(-\frac{\tilde{\alpha}}{1 + \tilde{\alpha} + \mu}, 0 \right], \\ \frac{\partial w_j^+}{\partial \ln H_{ij}^M} &= -\tilde{\alpha} \frac{\tilde{\alpha} w_j^- H_{ij}^M}{(1 + \mu + \tilde{\alpha}) \left[\beta w_j^- H_{jj}^M + \tilde{\alpha} w_j^+ H_{jj}^M \right] + \mu(1 - \beta) \underline{f} H_j^R Q_j^-} \in \left(-\frac{\tilde{\alpha}}{1 + \tilde{\alpha} + \mu}, 0 \right], \quad i \neq j \\ \frac{\partial w_j^+}{\partial \ln H_j^R} &= -\tilde{\alpha} \frac{(1 - \beta) \underline{f} H_j^R Q_j^-}{(1 + \mu + \tilde{\alpha}) \left[\beta w_j^- H_{jj}^M + \tilde{\alpha} w_j^+ H_{jj}^M \right] + \mu(1 - \beta) \underline{f} H_j^R Q_j^-} \in \left(-\frac{1}{\mu}, 0 \right], \\ \frac{\partial w_j^+}{\partial \ln H_{ik}^M} &= 0, \quad i, k \neq j \end{aligned}$$

Therefore, we have

$$\begin{aligned} \frac{\partial G_i^+}{\partial \ln H_{ij}^M} &\geq 0, & \frac{\partial G_i^+}{\partial \ln H_{kj}^M} &\leq 0, \quad k \neq i, & \frac{\partial G_i^+}{\partial \ln H_j^R} &\leq 0, \quad j \neq i \\ & & \frac{\partial G_i^+}{\partial \ln H_i^R} &\geq 0, & & \end{aligned}$$

with equality holding only when the respective population is zero. Therefore, Q_i^+ is maximized when

- H_{ij} is maximized for all j ,
- H_j^R is zero for $j \neq i$,
- H_{kj} is zero for $k \neq i$,
- H_i^R is maximized.

which yields, for all i , a finite upper bound on Q_i^+ and thus on equilibrium prices Q_i^* over the set of feasible populations. \square

Proposition 1.B.3 (Equilibrium existence). Assume that $\tilde{\mu} > 0$ and the support of \mathcal{F} is unbounded. Then an equilibrium exists for this economy.

Proof. First, for any feasible population vector H in the interior of \mathcal{H} , there is a unique equilibrium rent $Q_i^*(H)$, and it is a continuous function of H . Indeed, Q^* solves $G_i(Q^*) = 0$ for all i . The jacobian ∂G of G is of general term

$$\begin{aligned} \frac{\partial G_i}{\partial \ln Q_i} &= -(1 + \mu) - \frac{1}{F_i^d} \left(\tilde{\alpha}\beta w_i H_{ii}^M - (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha}^2 w_i H_i^M \right) < -\mu < 0 \\ \frac{\partial G_j}{\partial \ln Q_i} &= -\frac{\tilde{\alpha}\beta w_i H_{ji}^M}{F_j^d} > 0, \quad j \neq i. \end{aligned}$$

Thus,

$$\begin{aligned} F_i^d \left| \frac{\partial G_i}{\partial \ln Q_i} \right| - \sum_{j \neq i} F_j^d \left| \frac{\partial G_i}{\partial \ln Q_i} \right| &= (1 + \mu) F_i^d \\ &\quad + \left(\tilde{\alpha}\beta w_i H_{ii}^M - (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha}^2 w_i H_i^M \right) \\ &\quad - \tilde{\alpha}\beta w_i \sum_{j \neq i} H_{ji}^M \\ &= (1 + \mu) F_i^d \\ &\quad + \left(\tilde{\alpha}\beta w_i H_{ii}^M - (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha}^2 w_i H_i^M \right) \\ &\quad - \tilde{\alpha}\beta w_i (H_i^M - H_{ii}^M) \\ &= (1 + \mu) F_i^d + 2\tilde{\alpha}\beta w_i H_{ii}^M \\ &\quad - (1 - \beta) \underline{f} H_i^R Q_i + \tilde{\alpha}(\tilde{\alpha} - \beta) w_i H_i^M. \end{aligned}$$

If $\alpha > \beta$, the last term is positive and so is the rest of the expression. If $\tilde{\alpha} < \beta$, since $\beta < 1$ we have $\tilde{\alpha}(\tilde{\alpha} - \beta) < 1$ and so the expression is positive too. Therefore, ∂G is diagonal dominant with weights F_i^d , and since F_i^d is bounded given by

lemma 1.B.1 and $\partial_{ii}G_i$ is negative and bounded from below, results in Hadar (1969) hold. This shows existence. Further, since ∂G is diagonal dominant it is non-singular, and the implicit function theorem gives continuity.

Now define the following process for population flows and skill flows $H^t = \{(H_{ij}^{M,t}), (H_{ij}^{R,t})\}$:

$$H_{ij}^{M,t+1} = \int_0^\infty l \pi_{ij}(l, Q^*(H^t)) d\mathcal{F}(l), \quad H_{ij}^{R,t+1} = \int_0^\infty \pi_{ij}(l, Q^*(H^t)) d\mathcal{F}(l)$$

For any dwelling-workplace pair ij , and vector of equilibrium rents $Q^*(H^t)$, the probability of a worker with productivity l to choose ij is strictly positive if and only if (assuming positive amenities)

$$lw_j^*(H^t) - \underline{f}Q_i^*(H^t) > 0 \quad \iff \quad l > l_{ij}(H^t) \equiv \frac{\underline{f}}{A_j} Q_i^*(H^t) Q_j^*(H^t)^{\bar{\alpha}},$$

but since Q^* is bounded from above by lemma 1.B.2, there is a \bar{l}_{ij} that maximizes l_{ij} over population distributions. Thus, for all ij we have a non-zero minimum population H_{ij}^{R-} and workforce H_{ij}^{M-} . This shows that H^t stays in $\bar{\mathcal{H}} \equiv \{(H_{ij}^R, H_{ij}^M) \in \mathbb{R}^{J \times J} \mid H_{ij}^R \geq H_{ij}^{R-}, H_{ij}^M \geq H_{ij}^{M-}, \sum_{ij} H_{ij}^M \leq \bar{H}^M, \sum_{ij} H_{ij}^R \leq \bar{H}\}$, which is convex, closed and bounded. Further, π_{ij} are continuous functions of Q , w , A and B , which are themselves continuous over $\bar{\mathcal{H}}$. Existence therefore follows from Brouwer's fixed point theorem. \square

1.C Data

1.C.1 Data sources

Workers Microdata (DADS): The *Déclarations Automatiques de Sécurité Sociale* are an administrative, restricted-access dataset on the universe of French workers. Sent by employers to the social security administration on a yearly basis to be used for the computation of social security contributions. They contain the salaries, hours worked, occupation, workplace and dwelling place of every French employee. They are exhaustive on the universe of French private payroll employees and available from 1993 to 2015. However, it is not a proper panel as individual IDs are scrambled every two years. Absent data on education, I use occupation categories, and treat grey matter, managers and professionals as high skill workers and the rest of the workforce as low skill workers.

Household Expenditure survey: The *Enquête Budget des Familles* is a representative survey of French households expenditures conducted by the National Statistical Institute. It contains household composition, housing expenditures, household income and housing surface area. For the estimations, I pool the 2006 and 2011 waves of the survey.

Building transactions (DVF): The *Demande de Valeurs Foncières* is an open dataset, exhaustive on the universe of building transactions in France starting in 2014.

Land registry files (FF): The *Fichiers Fonciers* from the French tax administrations are an exhaustive dataset on the universe of French properties. They report, for each property in France, its floor space area and its fiscal status, either as a dwelling or as a place of business.

Travel Times (TT): Average road travel times between municipalities are computed using extractions of the road network from the OpenStreetMap project and the *dodgr* R package (Padgham, 2019). For the public transport network, I use publicly available GTFS transit timetables and compute travel times between municipality centroids at 8 in the morning on a tuesday.

1.C.2 Geographical units

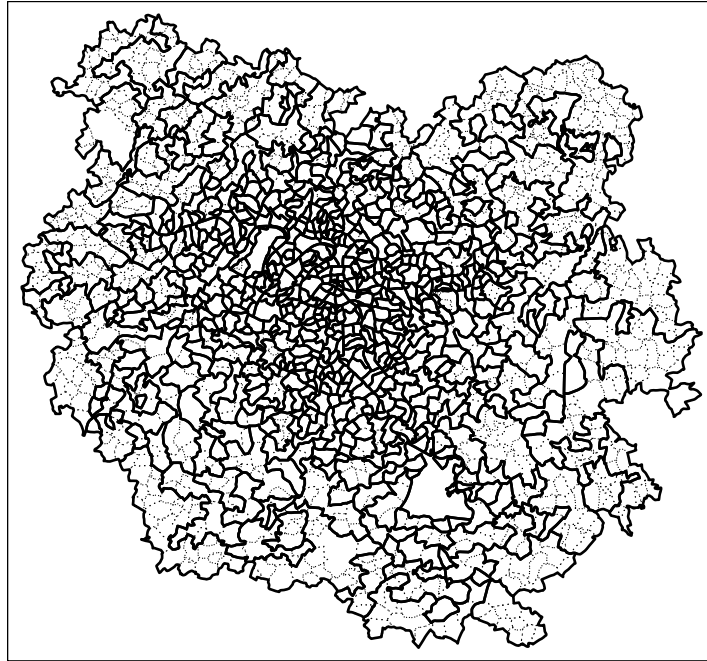
Because the estimation procedures used cannot handle geographical units with zero employment or zero residents, to ensure some precision in the estimation of local wages, rents, TFPs and amenities and to comply with legal regulations on exporting aggregates from restricted access microdata in France, I pull municipalities together into groups so that each group has at least 10 workers and 10 residents of each type. To minimize the heterogeneity between municipalities in a same group, I use a procedure that tries to minimize the rent differential between merged municipalities. More precisely, I use the following iterative procedure:

0. Create groups consisting of only one municipality. Make a list of the groups that do not meet the criterion.
1. If the list is empty, exit. Else, choose the first group of the list.
2. Amongst adjacent groups, find the one that has the closest average rent per squared meter and merge the two groups.
3. Place that group at the bottom of the list. Go to 1.

Rents are used to measure the distance between municipalities because it is the variable with the best coverage in the raw data, with no missing value at the municipal level. Second, rent is a good indicator of the general

attractiveness of a location as it is strongly correlated with income and population. I therefore expect that pooling neighboring municipalities with similar rents will also minimize the within unit variation in populations, income and amenities. Overall, the procedure leaves central, highly densely populated areas unchanged and only pools peripheral, almost empty locations. These locations are highly homogenous in their emptiness and inexpensiveness, and they mainly serve as an outside option to allow workers to move out of the city center in counterfactual simulations as they have little weight in the estimation.

Figure 1.C.1: Municipalities (dashed) and pooled units (solid) for the Urban Area of Paris.

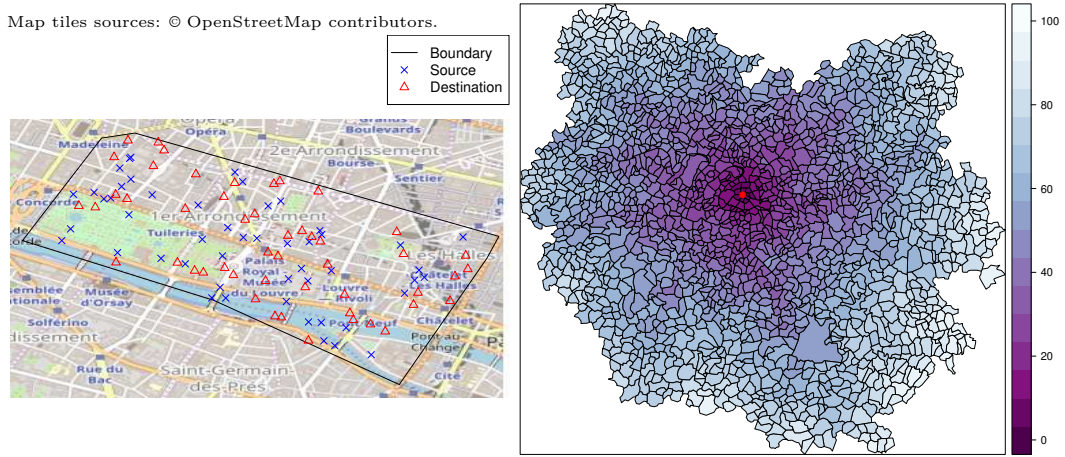


1.C.3 Travel times

Travel times by car are computed for all pairs ij using the road network extracted from OpenStreetMap. They are computed in minutes between each pair of

municipalities, and are theoretical travel times based on the road network and speed limits. Congestion is not taken into account. Figure 1.C.2b plots one line of the travel time matrix for the Urban Area of Paris. Travel times in the Paris area range from 7 minutes to two and a half hours.

Figure 1.C.2: Examples.



(a) Example of sample points

(b) Travel times in minutes from the 1st district of Paris (red dot)

To approximate the average travel time between municipalities, I average travel times between randomly drawn pairs of points within each municipalities. For each municipality pair, 50 origins and 50 destinations are randomly drawn. Figure 1.C.2a shows such a sample of origins and destinations within the first district of Paris. Given the 50 sources and 50 destinations, the 2500 pairwise travel times between them are computed and their average is taken as the average travel time within the municipality.

Travel times by public transport are computed for all pairs of municipalities using the street network from OpenStreetMap to find entry points and GTFS data on the transport network in the region from RATP and SNCF. These two data sources are fed into the OpenTripPlanner API. The public transport

travel times used in the chapter correspond total travel times by all means of public transport available, including walking time and waiting time, assuming a departure time at 8 AM on a Tuesday.

Chapter 2

Decentralization and Optimal Community Size: Justifications, Forms and Consequences of Inter-governmental Cooperation.

This paper was co-authored with Sonia Paty and published (in French) as Paty, S. & Ubeda, M. (2020). Décentralisation et taille optimale des collectivités locales : pourquoi, comment coopérer et avec quels effets ?. *Revue Française d'Économie*, 1(1), 99-138.

Abstract

In light of the recent pace of territorial and administrative reforms in decentralized countries, this article offers an analysis of inter-governmental mergers and cooperation mechanisms. Starting with a description of the existing institutional forms of fiscal consolidation, with a special focus on the French case, we then move on to the theoretical literature that underlies this phenomenon. Then, we summarize the empirical literature analyzing the effects and determinants of fiscal cooperation regarding economic variables such as growth, public spending and local taxation. Finally, we provide novel estimates of the effects of inter-municipal cooperation on households' localization and income in France. Using an event study design and controlling for local income and population growth, we find that although cooperation significantly increased the median income of residents in cooperating municipalities (by €60 per year on average), it did not impact the number of households living in these municipalities.

2.1 Introduction

An overview of the administrative landscape of OECD countries in the last twenty years shows two major tendencies: i) the level of fragmentation is varying greatly from one country to the other, from 31 local collectivities in Ireland to almost 35,000 in France and more than 38,000 in the United States (OECD, 2018); ii) there was a multiplication of re-centralization policies, i.e. mergers or municipal cooperation.

This movement towards re-centralization is meant to correct potential drawbacks of decentralization. Although common, in practice it can be implemented in several ways, ranging from mergers of municipalities to municipal cooperation through legal structures allowing the joint provision of a specific set of public goods. (Frère, 2012; Paty and Frère, 2014; Le Maux and Paty, 2020). Several countries have adopted the latter, e.g. France, Italy, Germany, Great-Britain, Spain, Portugal, Brazil among others.

This article aims to explain those re-centralization choices, that often stem from a wish from local governments and states to rationalize the supply of local public goods.

Within the economic literature, the subfield of local public economics offers explanations of the advantages and drawbacks of fiscal decentralization and municipal cooperation. Indeed, it focuses on the supply and funding of local public goods by autonomous local jurisdiction (Le Maux and Paty, 2020). Within this literature, the theory of fiscal federalism gives arguments for rationalizing decentralization and cooperation decisions. There are mainly two types of benefits from decentralization. First, decisions that are taken at a finer geographical level are more able to capture the heterogeneity of the preferences of citizens (Oates and Others, 1972). Second, because citizens are closer to policy makers, they are better informed about their actions, which allows them to exert a greater

control over the management of public funds. Those two arguments justify the major waves of decentralization throughout OECD countries at the end of the 20th century, that lead to an important jurisdictional fragmentation (Brühlhart et al., 2015).

For more than a decade however, we observe a reversal of this tendency in front of the inefficiencies caused by jurisdictional fragmentation. First, if jurisdictions get too small there can be spillovers in public good consumption, by which citizens benefit from public goods that they did not finance. Further, the presence of economies of scale in the production of certain public goods can be an additional source of inefficiency when their production get decentralized. Consequently, for many public goods the optimal provision zone might not align with the boundary of municipalities.

Finally, fiscal decentralization can also create inefficiencies through tax competition as municipalities fight for firms. Since the 1980's, the literature about tax competition has shown that the strategic behavior of local governments to attract a mobile tax base on their territory can lead to suboptimal tax rates, and therefore suboptimal levels of public spending (Wilson, 1999). It should also be noted that even in the absence of tax competition, decentralization could increase inequalities as local governments differ in their efficiency and resources.

Given the drawbacks of decentralization, re-centralization policies are expected to yield numerous benefits. First, they should allow to realize economies of scale on the production of some public goods. All else equal, this should allow for a decrease in public spending, an increase in the quality of public services, an increase in the number of public goods varieties, or a combination of the above. Further, extending the geographical area over which public goods are provided and financed should help internalizing spillover effects and reduce tax competition.

In this context, it seems important to understand the effects of fiscal re-centralization in the countries that implemented them. Did we see scale economies and increases in competitiveness? What were the consequences of cooperation on local taxes and spending? Were firms and households location decisions affected by the subsequent changes in local spending and taxes?

We will try to answer these questions in three parts. In section 1, we describe the practical ways in which re-centralization has been implemented in the last decade, with a particular emphasis on the French case. In section 2, we review the theoretical underpinnings of fiscal consolidation. In section 3, we review the empirical literature on the consequences of inter-municipal cooperation. Section 4 provides estimates of the effects of cooperation on incomes and populations. Section 5 concludes.

2.2 The institutional forms of recentralization

In order to correct for the inefficiencies introduced by an excessive fragmentation, several countries have put in place consolidation policies. They can take different forms that can coexist depending on the specificities of the institutional context. In summary, there are three types of consolidation policies : i) the transfer of the supply of some public services from a lower level of government to an existing higher level, ii) municipality mergers; and iii) the creation of inter-municipal cooperation structures that allow municipalities to collectively supply one or more public services.

The first type of policies, whereby the provision of public services is transferred from one level of government to a higher one, is quite rare. It can still be observed in some countries. One such example is the case of Norway, where in 2002 the

management of public hospitals was transferred from the regions to the states. In what follows, we will focus on the two latter types: mergers and cooperation.

Mergers are the option that has been chosen by some countries since the 1950s. It is the case of Sweden, that divided its number of municipalities by eight, and Austria that divided it by two. In 1975, the number of Belgian municipalities went from 2,359 to 596. In northern Europe, that process continued until the beginning of the 2000s. For instance, in 2007 Denmark reduced its number of municipalities from 271 to 98. Outside of Europe, mergers were also operated in Japan, Israel and Canada.

At the same time, inter-municipal cooperation was developed as an alternative way of merging the supply units of public services. Depending on their objective and their mode of financing, they can be associative or federative in nature.

Associative cooperation is the situation chosen by municipalities when they want to pool the provision of one or more public services without abandoning their fiscal autonomy. In that case, the resources used in the production of the public service come from direct contributions from the member municipalities to the cooperation entity, while the cooperation entity itself has no taxing power. This mode of cooperation is the most widespread in Europe. It can target a wide range of public services, such as water management, waste management, transport infrastructures, zoning policies, emergency services, environmental protection, cultural, touristic and economic policies, infrastructures and medical services. In France, this form of cooperation dates back to the creation, in 1980, of the *syndicats de communes*. Adjacent municipalities could, within this new framework, to pool the supply of one or more specific public goods without creating any specific new tax.

Less common in Europe, a second form of cooperation, federative, was strongly developed notably in France and in Germany. Within that arguably

stronger type of cooperation, the new inter-municipal entity is given direct control over newly created taxes in order to finance the production of public services.

Inter-municipal cooperation in France

In France, federative inter-municipal cooperation increased greatly with the 1999 *Chevènement* law under three main legal categories: *communautés de communes* (CC), *communautés urbaines* (CU), *communautés d'agglomération* (CA), and *métropoles*.

When only 5,069 municipalities were part of an inter-municipal cooperation structure in 1993, all of them were members of a federative cooperation structure (GFP) in 2014 (Table 2.2.1).¹ As a result, the share of the French population covered by one of these structures increased from 28% in 1993 to 79% in 2003, and finally 100% in 2014. In recent years, there is a large majority of CC and CA, those two categories accounting for 98% of French municipalities in 2014. However, given the sizeable differences in population between the municipalities choosing these two modes of cooperation, CCs and CAs only account for two thirds of the French population (Table 2.2.2), while *Métropoles* make up the rest.

Federative cooperation allows for the cooperation entity to provide public services using its own taxes. The ways in which these taxes are set and interact with municipal taxes varies depending on the type of structure. French law allows for three different types of local business tax (*taxe professionnelle*): a one-tax regime (*fiscalité unique*), a two-tax regime (*fiscalité additionnelle*) and a zone-specific regime (*fiscalité de zone*).

¹We can see a slight reduction in the total number of municipalities after 2015, following a law that promoted mergers.

Table 2.2.1: Number of municipalities depending on the type of inter-municipal cooperation

	CA	CC	CU	CV	District	Métropole	SAN	Total
1993	0	2085	251	30	2652	0	51	5069
1994	0	5556	251	49	3111	0	51	9018
1995	0	7709	251	49	3441	0	51	11501
1996	0	9695	271	49	3489	0	51	13555
1997	0	12221	286	86	3551	0	51	16195
1998	0	13780	309	87	3510	0	51	17737
1999	0	15113	309	87	3511	0	51	19071
2000	756	17451	311	34	2680	0	51	21283
2001	1428	19799	348	0	1792	0	47	23414
2002	1997	24389	353	0	0	0	47	26786
2003	2418	26842	354	0	0	0	52	29666
2004	2632	28407	355	0	0	0	34	31428
2005	2753	29166	355	0	0	0	34	32308
2006	2788	29745	356	0	0	0	34	32923
2007	2946	30080	358	0	0	0	29	33413
2008	3004	30245	360	0	0	0	29	33638
2009	2983	30745	409	0	0	0	29	34166
2010	3107	31225	413	0	0	0	29	34774
2011	3290	31298	424	0	0	0	29	35041
2012	3600	31232	398	0	0	46	29	35305
2013	4118	31428	434	0	0	46	23	36049
2014	4851	31246	445	0	0	49	23	36614
2015	4744	31116	201	0	0	512	15	36588
2016	4610	30154	359	0	0	735	0	35858
2017	7282	26740	624	0	0	765	0	35411
2018	7443	26424	523	0	0	963	0	35353
2019	7488	25926	589	0	0	963	0	34966

Note: CC: *communauté de communes*; CA: *communauté d'agglomération*; CU: *communauté urbaine*; CV: *communauté de ville*; SAN: *syndicat d'agglomération nouvelle*.
Source: DGFIP; DGCL.

The one-tax regime is mandatory for CA establishments, and optional for CC and CU. In this setting, cooperating municipalities completely transfer their

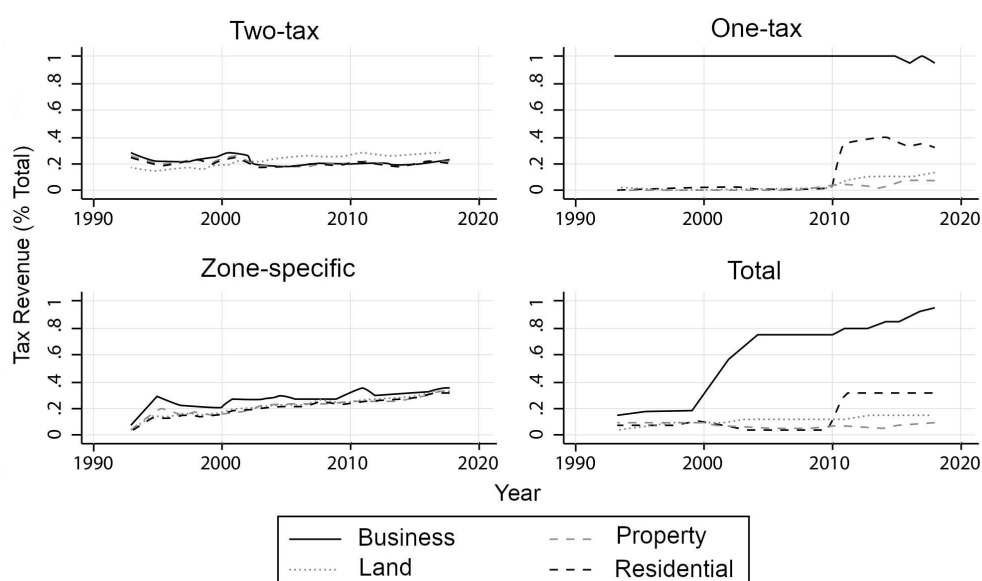
Table 2.2.2: Population per type of inter-municipal cooperation, 2019

	Number	Total Pop. ^a	Average Pop.
<i>Métropole</i>	22	19.2	873 349
CU	13	2.9	220 896
CA	223	22.9	102 821
CC	1 001	21.5	21 482
Total GFP	1 259	66.5	52 834

^a: Total population in millions. Source: DGFîP; DGCL; INSEE. 2019 geography, 2017 populations.

ability to levy the local business tax to the new cooperation entity. This gives rise to a unique business tax over the territory covered by the cooperating municipalities.

Figure 2.2.1: Tax levied by inter-municipal structures as a proportion of total municipal tax revenues



Note: Taxes levied by inter-municipal structures over the total tax revenues from inter-municipal structures and municipalities, for each local tax. Panels 1 to 3 are restricted to municipalities that belong to a cooperation structure of the given type, while the last (Total) panel includes all municipalities in France.

Source: DGFîP; DGCL.

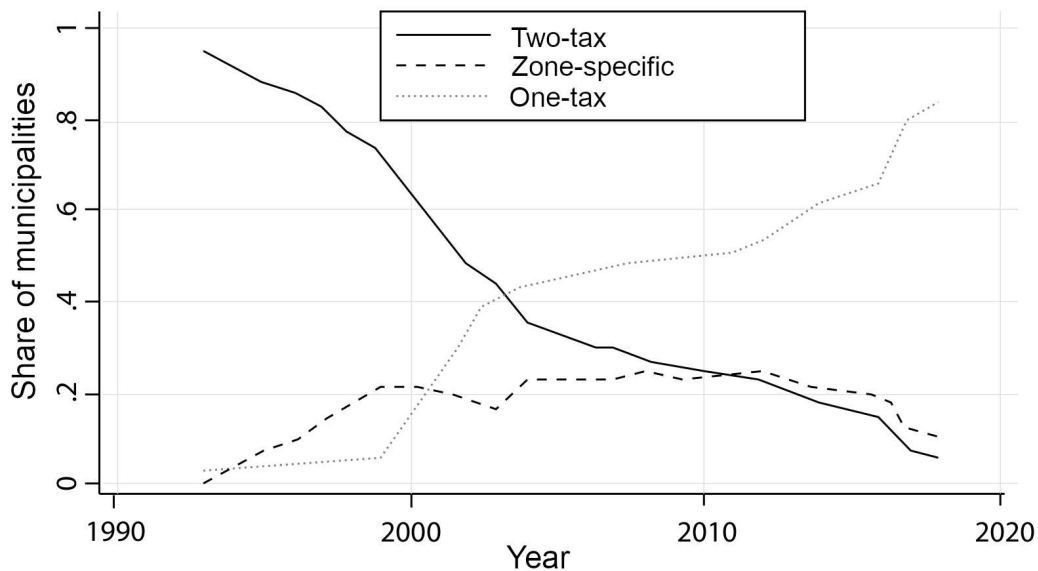
On top of the local business tax, municipalities and inte-municipal cooperation structures have three other tax instruments: i) a land tax, supported by owners of unbuilt land ii) a property tax on building values and iii) a residential tax paid by residents, proportional to the size of their housing. Although the legal type of cooperation constrains the property tax, municipalities and their cooperation groups are free to set the other three taxes, irrespective of their type. Although one-tax groups are fully integrated with respect to the business tax, up until 2010 their fiscal integration with respect to the other taxes was almost inexistent (Figure 2.2.1, panel 2). Indeed, up until 2010 those cooperation structures only levied 2% of the total land, property and residential taxes of the municipal block (the sum of municipalities and cooperation structures). Following a 2010 reform that removed the property tax of counties (*Départements*) in favor of the municipal block, their fiscal integration deepened. In 2018, one-tax groups get 8%, 13% and 32% of the property, land and residential taxes respectively.

At the opposite side of the spectrum are the two-tax cooperation groups. In this configuration, municipalities still decide freely on their property tax, while the cooperation structure is free to set an additional property tax rate, that applies uniformly to all the municipalities of the group. These groups levy 20% of the total tax revenues of the municipal block, and this figure is stable across taxes and over the 1993-2018 period (Figure 2.2.1, panel 1).

Finally, the zone-specific regime offers an intermediate level of integration. While municipalities are free to set their business tax rate over the majority of their territory, they decide collectively upon a set of activity zones with a common rate. For the three other local taxes, these groups are the most integrated on average as they perceive, in 2018, a third of the fiscal revenues of the municipal bloc (Figure 2.2.1, panel 3).

Overall, fiscal integration of French municipalities increased steadily over the period, with an almost complete integration of the property tax in 2018. Indeed, whereas cooperation groups levied 13% of the total property tax revenues in the country in 1993, they now levy 93% of this tax (Figure 2.2.2, panel 4). Although fiscal integration was the strongest for the business tax, fiscal integration over the other types of taxes increased strongly too over the period. Indeed, in 2018 cooperation groups levy 32% of the residential tax, 15% of the land tax and 9% of the property tax, compared to 7%, 3% and 6% respectively in 1993.

Figure 2.2.2: Share of cooperating municipalities choosing each mode of cooperation



Source: DGFIP; DGCL.

This evolution can be explained by the joint increase of cooperation as a whole on the one hand, and of the adoption of the one-tax system on the other, as illustrated in Figure 2.2.2. Indeed, while 95% of French municipalities that were part of a group were in a two-tax groups in 1993, this figure dropped to

5% in 2018. In the meantime, the share of one-tax groups steadily increased to reach 83% of French municipalities in 2018.

If the December 16, 2010 law made it mandatory for French municipalities to join a cooperation group by 2014, it is interesting to note that in 2009, 94% of French municipalities already chose to join one. Among them, 73% chose to forego at least parts of their fiscal autonomy by choosing a one-tax or a zone-specific system. The next section reviews the economic arguments underpinning this decision.

2.3 Why cooperate

Municipal cooperation finds its main justification in it allowing to exploit economies of scale in the production of public services, as well as internalize spillover effects in the consumption of those services (Le Maux and Paty, 2020). In the local public sector, scale economies could rise from a variety of mechanisms, among which fixed costs, technological improvements, increasing bargaining power with suppliers or access to better financial instruments. These can notably be expected for transport infrastructures as well as water, energy and waste management.

Second, increasing the area over which the public good is supplied should favor the internalization of spillover effects. Indeed, freeriding behaviors could happen within municipality groups when a municipality offers public services that benefit the inhabitants of neighboring municipalities that do not participate in its funding. Those externalities then lead to an underprovision of the public good.

Further, municipal cooperation, at least in its federative form, can be justified by its mitigating effects on tax competition. Indeed, with a mobile tax base the

strategic behavior of local governments, who try to avoid losing their tax base, leads to a race to the bottom in tax rates (Wilson, 1999). It follows that taxes and public goods provision are sub-optimal.

Possible mitigation strategies then involve reducing the number of municipalities by imposing mergers (Hoyt and Rosenthal, 1997; Wilson, 1999), or widening the zone over which the tax is levied. Indeed, the higher the number local governments competing for the local tax base, the higher the fiscal externalities and thus the deviation from the optimal situation. By lowering the number of competing governments, these fiscal externalities are partially internalized.

The literature on tax competition also provides reasons why local governments would resist cooperation. A first reason is heterogeneity in endowments. Assuming benevolent social planners, Bucovetsky (1991, 2009); Wilson (1991); Kanbur and Keen (1993) among others show that small municipalities might resist fiscal cooperation. Bucovetsky (1991); Wilson (1991) introduce explicitly population heterogeneity in a tax competition game. Bucovetsky (1991); Wilson (1991) show that in the asymmetric Nash equilibrium, the bigger municipality sets a higher tax rate than the small one. If the size differences are big enough, the smaller municipality can be worse off under equal tax rates than under tax competition, as it cannot lower its tax rate to attract a bigger fiscal basis and compensate for its smaller labor force.

Moving away from the benevolent social planner hypothesis, Brennan and Buchanan (1980); Keen (1998); Edwards and Keen (1996) argue that fiscal cooperation moves the economy away from the optimum. This is because they assume that policy makers are rent-seekers, which leads to equilibrium tax rates that are above the optimum. In this context, tax competition creates a downward pressure on tax rates, bringing them closer to the optimum. In this situation however, although it does not benefit their citizens local governments

should still favor fiscal cooperation, as the decrease in tax competition would allow them to extract a higher rent.

Empirically, the literature has emphasized several economic, socio-demographic and political factors that can explain the decision of municipalities to cooperate.

Bischoff and Wolfschuetz (2017) show, on a sample of German municipalities, that municipalities are more likely to cooperate with municipalities that share their socio-economic characteristics. The authors underline homophily, but also the role of preferential state transfers in the emergence of inter-municipal cooperation.

In France, Di Porto et al. (2017); Di Porto and Paty (2018) also report that state transfers, amongst other determinants, play an important role in the decision to cooperate, as all else equal the only municipalities that decided to cooperate are the ones that saw their state transfers increase following this decision. Further, they show that there is a strong mimicking behavior, whereby municipalities are more likely to join an inter-municipal cooperation structure if their neighbors did so. On the other hand, proximity between the mayor of the municipality and the president of the cooperation structure is irrelevant to the decision to join the group. Further, they show that socio-demographic characteristics are important. All else equal, richer municipalities are less likely to cooperate, probably because they anticipate redistributive effects that would negatively affect them.

Regarding the costs of cooperation, Tricaud (2019) shows that they differ according to the status of the municipality. More precisely, she shows that rural municipalities might refuse to cooperate when they anticipate a decrease in the quality of public services. Urban municipalities on the other hand might avoid cooperation because of congestion costs. Indeed, when municipalities join a cooperation group, they transfer the power to deliver building permits

to the group. She shows that, following their forced entry after 2010, urban municipalities that refused to cooperate experienced a strong increase in building permits delivered.

2.4 The economic impacts of cooperation

Several authors tried to measure the effects of cooperation in countries where reforms similar to the French one were adopted. Without trying to be exhaustive, we summarize here some of their results about scale economies, local growth, taxation and spending.

The effects of local consolidation policies did not necessarily met the expectations outlined in the previous section, particularly regarding scale economies (Lago-Peñas and Martínez-Vázquez, 2013). They depend strongly on the institutional context and the type of consolidation policy.

Blume and Blume (2007) show that the German municipal mergers operated in the 70s had significant positive effects on local economic growth that they attribute to economies of scale in the production of public goods. Interestingly, softer forms of consolidation through functional cooperation did not have these positive effects.

This study is part of a broader literature that studies the effects of decentralization on economic growth in different institutional contexts. The meta-analysis of Baskaran et al. (2016) shows that studies at the national level tend to find positive results, while comparative studies yield more mitigated results. This reinforces the idea that the specificity of consolidation policies matters.

We can also wonder if cooperation lead to an increase in local tax rates, as predicted by the tax competition models summarized above. Looking at the French local business tax over the 1993-2003 period, Charlot et al. (2015)

find that fiscal cooperation did indeed reduce tax competition and lead to an increase in tax rates. These results, obtained using panel data and spatial econometrics methods, were confirmed in a DiD setting by Breuillé et al. (2018). They further extend those results by showing that all four tax rates (professional, land, property and residential) increased significantly. Additionally, they show that while taxes of the municipal bloc (municipality plus cooperation group) increased, municipal tax rates decreased, and they did so more strongly for smaller municipalities.

If fiscal cooperation lead to an increase of tax rates, the effect on spending is less clear cut. Economies of scale should allow to reduce spending, all else equal. Further, transferring the production of some public goods to the inter-municipal level should mechanically reduce municipal spending. This prediction was confirmed by Ferraresi et al. (2018) confirm those results in Italy, as they show that fiscal cooperation lead to a 5% decrease in spending with no decrease in the quality of public services. Further, Reingewertz (2012) finds similar results in Israel.

In France however, Frère et al. (2014) find no effect of cooperation on total municipal spending. This could result from a positive relationship between the range of public services and populations, as suggested by Oates (1988). Indeed, Frère et al. (2011) do find evidence of such a “zoo effect” amongst French municipalities. Further, as suggested by the French Court of Auditors (Cour des Comptes, 2005) it might be possible that the transfer of services was only theoretical in a lot of cases, where the municipality kept offering specific public goods that were supposed to be transferred to the cooperation structure.

A final prediction of the theoretical literature is that fiscal cooperation should allow to internalize spillover effects in the provision of public services. Frère et al. (2014) test this idea by looking at the spatial correlation of public spending across

municipalities. They find significant spending interactions between cooperation groups, but not within them, while [Ermini and Santolini \(2010\)](#) also report that fiscal cooperation lowers spending interactions. These results suggest that fiscal cooperation did allow to at least partially internalize spillovers.

2.5 Cooperation, incomes and populations

As discussed before, in theoretical models of tax competition with heterogeneous localities, the municipalities with the smallest endowments can use tax rates to attract more of the mobile basis. As a result, fiscal harmonization should reinforce the advantage of the center over the periphery. Indeed, if tax rates are homogeneous firms should favor more central locations, that benefit from higher endowments and higher productivities.

At the same time, economic geography shows that the spatial concentration of productive activities benefits productivity and wages through agglomeration effects ([Combes and Gobillon, 2015](#)). Furthermore, these effects are highly spatially concentrated and evidence shows that they mainly operate in a radius of around ten kilometers ([Rosenthal and Strange, 2008](#); [Di Addario and Patacchini, 2008](#)). The relocation of firms in central locations and the subsequent agglomeration effects should then, all else equal, generate wage gains for residents.

On the other hand, the literature on household sorting between jurisdictions ([Tiebout, 1956](#); [Epple and Platt, 1998](#); [Banzhaf and Walsh, 2008](#); [Boustan, 2013](#); [Brühlhart et al., 2015](#); [Oddou, 2016](#)) predicts that all else equal, households should sort according to their preferences for taxation and local public spending. Therefore, the positive effects of cooperation on the range and quality of public spending could make cooperating municipalities more attractive to residents. For instance, [Tricaud \(2019\)](#) shows that joining a cooperation group more than tripled

the probability of a municipality to be connected to a public transit network. On could therefore expect a positive effect of cooperation on attractivity.

To further investigate these effects, we analyze the effects of inter-municipal cooperation amongst French municipalities on the income of their residents and their total population. We do so using an event-study design, and show that our results are robust to controlling for local economic variables.

More precisely, we estimate the following equation

$$y_{it} = \mu_i + \delta_t + \sum_{k=-3, k \neq -1}^{k=3} \alpha_k z_{it+k} + \alpha_{-4} z_{i < t-3} + \alpha_4 z_{i > t+3} + \epsilon_{it}, \quad (2.1)$$

where y_{it} is the median income or the number of residents in a municipality i at year t , z_{it} is a dummy equal to 1 when a municipality is part of a cooperation group, and ϵ_{it} is an error term. Finally, μ_i and δ_t are respectively municipality and year fixed-effects. In our sample, t goes from 2001 to 2011. Further, we restrict the sample to a balanced panel of 18,293 municipalities from mainland France who joined a cooperation structure after 2000 and for which median incomes and populations are available over the whole period.

Figure 2.5.1: Variations of median income and number of households around the entry in a federative cooperation structure

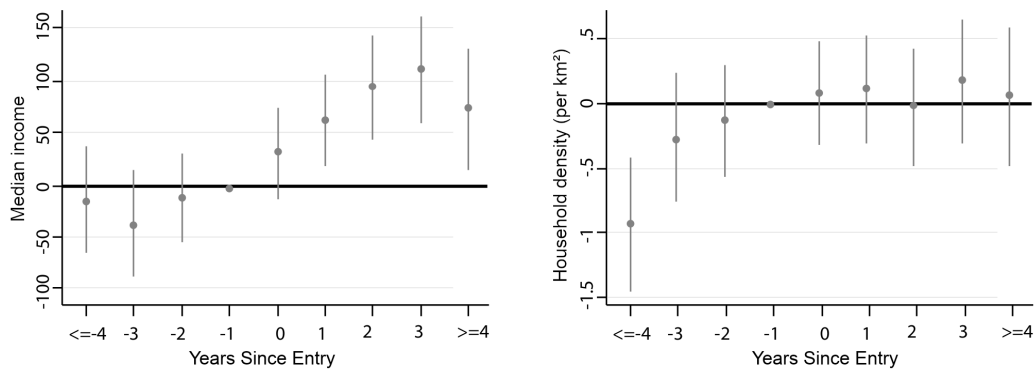


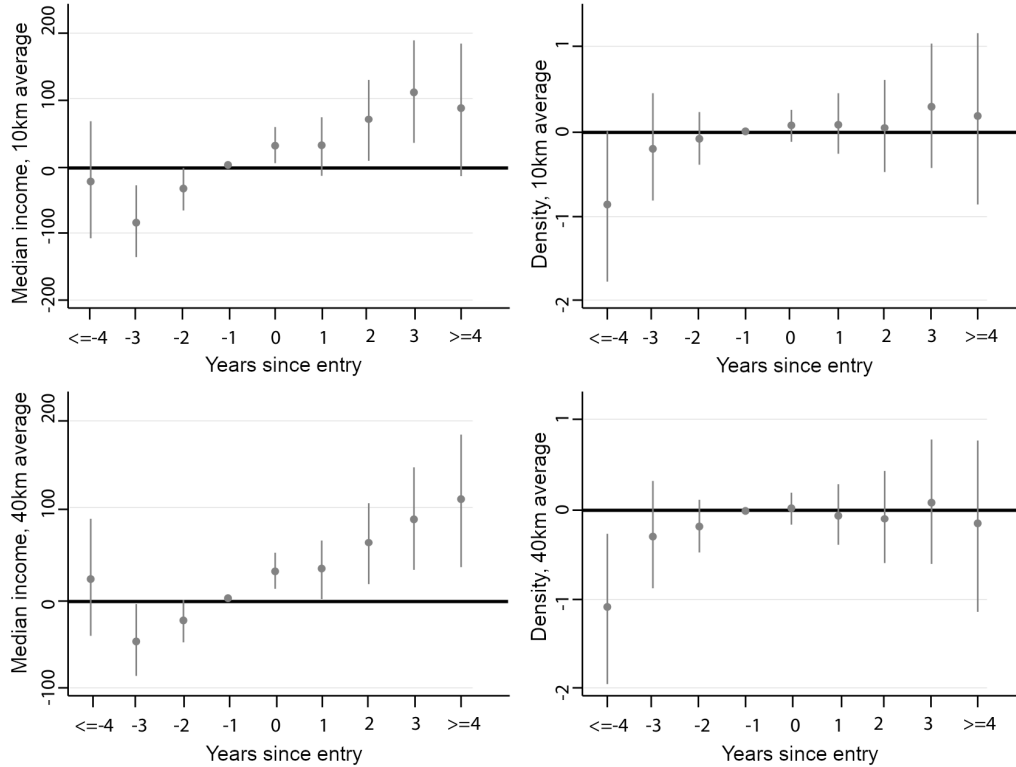
Figure 2.5.1 shows the results of this regression, for (yearly) median incomes on the left panel and for household density on the right panel. On average, the effect on median income after 3 years is at €100, while populations stay constant.

A major problem in the estimation of such an equation is the potential for confounding factors due to the selection of some particular types of municipalities into treatment. In particular, larger and more productive municipalities do not benefit from tax competition in the same way as smaller ones, and the expected gains from cooperation could vary depending on municipal characteristics. In particular, Di Porto et al. (2017) show that denser or poorer municipalities are more likely to cooperate than small or rich jurisdictions. One should therefore expect that entry is correlated to the error term in our estimating equation. This worry is reinforced by the presence of significant pre-event effects on population in panel 2 of Figure 2.5.1.

To mitigate this problem, we evaluate the robustness of our results to using local variations of economic variables as a proxy for the potential confounding factors. More precisely, we include the average of the dependent variable in neighboring municipalities as a control. For each municipality and each year, we compute the average of the median income and the population density over municipalities within a radius of X kilometers from the center of the municipality (where X varies from 10 to 80 kilometers), excluding the municipalities that end up joining the same cooperation group. Our assumption is that this variable should capture the local confounding factors that could influence the decision to cooperate of municipalities.

Figure 2.5.2 shows the evolutions, around the entry date of a municipality, of the mean median income and density in a radius of 10km and 40km around the municipality, excluding the municipalities that will eventually join the same

Figure 2.5.2: Variations median income and number of households around the municipality around the entry in a federative cooperation structure



group. We find that neighboring municipalities have a dynamic for both these variables that is very similar to the one of the treated municipalities. In particular, neighbors tend to be significantly poorer and less densely populated before the entry, and then see an increase in their median income. It therefore seems that the decision to join a cooperation group is not independent from the dynamics of local economic variables, which confirms the need to take them into account.

These variables are, however, only imperfect controls of the local economic variables that could influence entry decision. We therefore use the method developed by [Freyaldenhoven et al. \(2019, thereafter FHS\)](#), that allows to correct for this imperfect control issue. Intuitively, this method estimates the

link between controls and the dependent variable before the treatment occurs, and then uses this relationship to subtract the trend in confounding factors from the estimated effects. Practically speaking, the estimation proceeds by instrumenting the control with future values of the treatment variable.

Method

In this subsection, we summarize the main result of FHS and the underlying identification assumptions. Suppose to clarify the exposition a simpler version of equation (2.1) that abstract from dynamic effects, and in which variables have been demeaned to get rid of the fixed effects. Let η_{it} denote the confounding factors. This variable is supposed to capture all of the unobserved factors that influence both the outcome and the entry decision of municipality i at year t :

$$y_{it} = \beta z_{it} + \gamma \eta_{it} + \epsilon_{it}, \quad (2.2)$$

where ϵ_{it} is an error term and γ is a parameter. Suppose moreover that the control variable is only partially correlated with the unobserved factors

$$x_{it} = \lambda \eta_{it} + u_{it}. \quad (2.3)$$

FHS assume the following exclusion restriction: there exists some $L > 0$ such that for all $0 < l < L$, $E(z_{it+l}\epsilon_{it}) = 0$ and $E(z_{it+l}u_{it}) = 0$. The first condition states that η_{it} captures the confounding factors, so that the remaining error term is uncorrelated with the entry decision. The second states that, outside of the confounding factors, the anticipated entry decision is uncorrelated with the proxy. In particular, there can be no direct effect of the treatment on the proxy. We come back to this assumption in the next subsection.

They then show that under these conditions and assuming $\lambda \neq 0$, the following equation is identified via the method of moments estimator where x_{it} is instrumented by z_{it+l} :

$$y_{it} = \beta z_{it} + \frac{\gamma}{\lambda} x_{it} + \mu_{it}. \quad (2.4)$$

Identifying assumption and spillover effects

In the context of the present study, the exclusion restriction in FHS means that the correlation between local economic outcomes and entry should come solely from the confounding factors.

Practically speaking, we therefore have to assume that one municipality joining a cooperation group has no effect on the neighboring municipalities. Clearly, if an effect is to be expected on the municipality itself, this assumption cannot hold if we include in our average the neighbors that also joined the group. For this reason, we exclude them from the computations of the local averages.

But even doing so, spillover effects could still imply a direct effect of the treatment of a municipality on its neighbors. It can in particular be the case if the effects of municipal cooperation come from agglomeration effects or firms and households relocalization. If cooperation has beneficial effects on wages through the relocalization of firms and agglomeration effects within cooperating municipalities, then these benefits could spillover to the residents of neighboring municipalities. If the newly cooperating municipalities attract more residents, they might originate from neighboring non-cooperating municipalities, creating negative spillover effects.

Although these spillover could bias our estimates, note however that they should not yield false positives. If the policy has no effects, the spillovers should be zero too. Indeed, assume that equation (2.3) is misspecified, so that the true

model is in fact

$$x_{it} = \lambda\eta_{it} + \alpha\beta z_{it} + u_{it}, \quad (2.5)$$

i.e. a share α of the effects of cooperation on i spillovers to the neighboring municipalities. In this case, neighboring municipalities receive $\alpha\beta$ when i receives β . Under this alternative hypothesis and maintaining the assumptions of FHS, equation (2.4) identifies $\beta(1 - \alpha\frac{\gamma}{\lambda})$ instead of β . The coefficient is indeed biased, but under the null hypothesis that $\beta = 0$, this coefficient is still equal to zero.

Economically, this assumption states that a cooperation structure cannot impact neighboring municipalities without assuming its members get impacted too. For instance, neighbors cannot benefit from the extension of a transport infrastructure or suffer from outmigration if the treated municipality do not, conversely, benefit from that network or an increase in populations. In addition, we can expect that unobservable local economic variables affect neighboring municipalities in the same direction, so that $\frac{\gamma}{\lambda} > 0$. In that case, positive spillovers would create an attenuation bias while negative spillovers would lead to inflated coefficients.

Results

In table 2.5.1, we report results of the estimation of equation (2.4) with median incomes as the dependent variable. The first column reports the effects of entry controlling only for municipal and year fixed-effects, while the other six control the population-weighted average of median income over radius ranging from 10 kilometers to 80 kilometers. The effects stay stable at around €65 in all specification (corresponding to 0.2% for the average municipality in the sample) except the second one, where the instrument is slightly underpowered. The control is instrumented using leads 1 to 4 of the treatment status. This is the

Table 2.5.1: Effects of belonging to a cooperation structure on median income, controlling for local economic variables

	Baseline	10 km	20 km	30 km	40 km	60 km	80 km
Coop.	67.64** (20.91)	57.99** (21.41)	64.72*** (16.83)	65.91*** (16.75)	65.63*** (16.93)	65.48*** (17.02)	65.43*** (17.06)
Neighbors		0.195 (0.255)	0.0627 (0.204)	0.0402 (0.178)	0.0454 (0.183)	0.0472 (0.181)	0.0477 (0.181)
F first		4.199	12.57	18.46	17.72	18.13	18.11
J		1.667	2.499	2.558	2.549	2.543	2.542
$Pr < J$		0.644	0.476	0.465	0.466	0.468	0.468
N	128095	126563	127637	127813	127813	127813	127813

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. F first: Fisher test of joint significance of the instruments in the first stage equation. J : Sargan-Hansen statistic. $Pr < J$: associated p-value.

Note: “Neighbors” is the population-weighted average of the dependent variable in a radius of X kilometers around the municipality, where X is the column title. Municipalities belonging at any period to the same cooperation group are excluded. It is instrumented using leads 1 to 4 of the treatment variable.

maximal amount of variation that we can exploit in the sample knowing that all municipalities are treated by 2014. These instruments are indeed significant in all the first-stage equations (F first line in the table). Further, the coefficient on the control is not statistically significant in any of the specifications, which indicates that there is no confounding variable, at least none that our proxy can pick up.

Table 2.5.2 reports results of a similar exercise replacing median income with the number of households per squared kilometers. The baseline estimates, without controls, give a positive but insignificant effect (0.35, $se=0.226$). Once we control for the dynamics of neighbors however, signs flip and the coefficients gets really close to zero (-0.03, $se=0.14$ in the 20 kilometers specification). Further, the coefficient on the control is positive and significant. This confirms the presence of confounding factors related to population and cooperation that are captured by our proxy. Overall, these estimations indicate a null effect of cooperation on populations.

Table 2.5.2: Effects of belonging to a cooperation structure on population density, controlling for local economic variables

	Baseline	10 km	20 km	30 km	40 km	60 km	80 km
Coop.	0.354 (0.266)	-0.122 (0.152)	-0.0340 (0.141)	-0.0112 (0.140)	-0.00580 (0.139)	-0.00679 (0.140)	-0.00597 (0.140)
Neighbors		0.961*** (0.194)	0.778*** (0.154)	0.728*** (0.143)	0.714*** (0.141)	0.708*** (0.140)	0.707*** (0.140)
<i>F</i> first		5.241	8.604	10.25	10.77	10.97	11.02
<i>J</i>		0.222	0.124	0.0912	0.0517	0.0404	0.0385
<i>Pr</i> < <i>J</i>		0.974	0.989	0.993	0.997	0.998	0.998
N	162764	160509	161659	161859	161859	161859	161859

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. *F* first: Fisher test of joint significance of the instruments in the first stage equation. *J*: Sargan-Hansen statistic. *Pr* < *J*: associated p-value.

Note: “Neighbors” is the population-weighted average of the dependent variable in a radius of X kilometers around the municipality, where X is the column title. Municipalities belonging at any period to the same cooperation group are excluded. It is instrumented using leads 1 to 4 of the treatment variable.

One could still suppose that there is an effect, but that its estimate is biased downward by spillover effects that would contaminate our estimates. Note first that as $\frac{\gamma}{\lambda} > 0$, it would take a positive spillover effect to bias our estimate downward. Assuming as in the previous subsection that spillovers are a fixed share of the effect on treated municipalities, recall that the bias on the estimated parameter would be $1 - \alpha \frac{\gamma}{\lambda}$. Assuming a positive treatment effect, we can use this formula to get a ruff estimate of the size of the spillovers necessary to produce a null effect. As the parameter on the control variable is less than one in all specifications, we would need a spillover effect on neighboring municipalities at least as big as the direct effect on treated municipalities to rationalize our zero estimates. As this also holds true for the 80km specification, this would mean that for each additional inhabitant per squared meters due to fiscal cooperation in the treated municipalities, average density in untreated municipalities in a radius of 80 kilometers also increases by one. Our preferred interpretation is that there is no effect of fiscal cooperation on total population.

In the end, this empirical analysis confirms the positive effect on median incomes, while showing no statistically significant effect on populations.

2.6 Conclusion

In this article, we offer an analysis of the widespread phenomena of fiscal consolidation. After a tendency to decentralization at the end of the 20th century, several countries have implemented fiscal consolidation policies. The goal of these recentralization policies was to correct for the drawbacks of what seemed like an excessive fragmentation of public goods provision, mainly spillovers and losses in efficiency.

Supported by theoretical arguments, the empirical literature broadly confirms the efficiency gains of fiscal consolidation in terms of public goods provision. Overall, total spending either decreased or stayed constant while the quality and the diversity of public services increased. At the same time, tax competition was reduced which allowed for an harmonization of tax rates within cooperation groups.

In the empirical section of this article, we show that fiscal cooperation in France had a positive effect on incomes but no significant on total populations. More precisely, we estimate an average effects of around €60 per year, corresponding to a 0.2% gain at the mean. Combined with our null result on populations, existing evidence in the literature that shows a significant effect on firms localization within functional areas suggests that this effect on incomes stems from productivity gains rather than population sorting. Further investigations of migration flows would be necessary to disentangle more clearly these mechanisms.

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2.A FHS, dynamic specifications

Table 2.A.1: Median incomes, dynamic FHS specification

	<10 km	<20 km	<30 km	<40 km	<60 km	<80 km
Neighbors	-2.078 (6.224)	-1.001 (1.608)	-0.925 (1.400)	-0.965 (1.598)	-0.974 (1.671)	-0.975 (1.685)
Entry, $t - 4$	-68.18 (336.5)	-2.153 (121.3)	5.810 (110.6)	5.844 (112.5)	5.679 (112.9)	5.274 (113.1)
Entry, $t - 3$	-204.1 (549.1)	-84.78 (124.9)	-78.17 (109.9)	-79.61 (117.2)	-81.20 (121.4)	-81.69 (122.4)
Entry, $t - 2$	-90.25 (262.3)	-32.71 (68.71)	-35.34 (66.62)	-36.07 (70.28)	-36.64 (72.06)	-36.81 (72.45)
Entry, $t - 1$	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
Entry, t	102.1 (225.2)	62.25 (65.02)	64.78 (64.55)	67.48 (72.23)	68.85 (76.08)	69.20 (76.93)
Entry, $t + 1$	131.8 (252.0)	92.15 (84.75)	96.36 (84.13)	98.74 (91.32)	100.9 (96.00)	101.3 (97.02)
Entry, $t + 2$	249.0 (509.1)	153.7 (136.4)	156.3 (131.2)	160.4 (144.5)	162.9 (151.6)	163.6 (153.3)
Entry, $t + 3$	341.6 (777.4)	192.8 (185.8)	194.4 (175.2)	198.9 (192.3)	203.1 (203.8)	204.1 (206.2)
Entry, $t + 4$	260.0 (631.2)	172.7 (209.9)	181.5 (206.1)	187.4 (227.2)	192.4 (240.4)	193.3 (242.8)
F first	0.489	4.415	5.771	5.403	5.251	5.222
N	126314	127374	127538	127538	127538	127538

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. F first: Fisher test of joint significance of the instruments in the first stage equation.

Note: “Neighbors” is the population-weighted average of the dependent variable in a radius of X kilometers around the municipality, where X is the column title. Municipalities belonging at any period to the same cooperation group are excluded. It is instrumented using leads 5 and 6 of the treatment variable.

Table 2.A.2: Population density, dynamic FHS specification

	<10 km	<20 km	<30 km	<40 km	<60 km	<80 km
Neighbors	1.207*** (0.305)	1.016*** (0.291)	0.983*** (0.277)	0.982*** (0.275)	0.976*** (0.275)	0.975*** (0.275)
Entry, $t - 4$	0.151 (0.358)	0.115 (0.336)	0.134 (0.339)	0.160 (0.342)	0.169 (0.345)	0.171 (0.346)
Entry, $t - 3$	-0.0319 (0.233)	-0.0316 (0.216)	-0.00831 (0.218)	0.0180 (0.221)	0.0281 (0.223)	0.0300 (0.224)
Entry, $t - 2$	-0.0311 (0.148)	-0.00602 (0.146)	0.00773 (0.147)	0.0225 (0.149)	0.0311 (0.151)	0.0332 (0.152)
Entry, $t - 1$	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)	0 (.)
Entry, t	-0.0530 (0.104)	0.00706 (0.0837)	0.0377 (0.0788)	0.0512 (0.0778)	0.0531 (0.0775)	0.0549 (0.0776)
Entry, $t + 1$	-0.0239 (0.167)	0.0915 (0.141)	0.122 (0.132)	0.134 (0.129)	0.134 (0.128)	0.136 (0.128)
Entry, $t + 2$	-0.117 (0.223)	0.0212 (0.188)	0.0584 (0.177)	0.0691 (0.174)	0.0668 (0.174)	0.0688 (0.174)
Entry, $t + 3$	-0.182 (0.338)	0.0255 (0.288)	0.0735 (0.271)	0.0831 (0.267)	0.0815 (0.267)	0.0839 (0.266)
Entry, $t + 4$	-0.176 (0.443)	0.0637 (0.385)	0.136 (0.363)	0.154 (0.357)	0.153 (0.357)	0.156 (0.356)
F first	6.654	8.614	9.004	9.032	9.064	9.078
N	126469	127380	127544	127544	127544	127544

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$. F first: Fisher test of joint significance of the instruments in the first stage equation.

Note: "Neighbors" is the population-weighted average of the dependent variable in a radius of X kilometers around the municipality, where X is the column title. Municipalities belonging at any period to the same cooperation group are excluded. It is instrumented using leads 5 and 6 of the treatment variable.

Chapter 3

Inter-municipal Cooperation and
the provision of local public
goods: Economies of scale or
"zoo" effect?

Abstract

Inter-municipal communities are supposed to provide local public services more efficiently by exploiting economies of scale and reducing spillover effects among cooperating municipalities. In a diff-in-diff setting that exploits the staggered adoption of cooperation in France, we explore the impact of inter-municipal cooperation on both local public spending and revenues. We first find a sizable increase in local public spending which was not driven by wage bill expansion. Second, by using the decomposition of spending by function, we show that this increase was driven by urbanism policies. Third, we show that a quarter of this effect can be explained by the transfer of three policies: public transit, economic development and garbage collection. Overall, we conclude that scale economies, if existent, were clearly dominated by a "zoo" effect, i.e. the provision of new public services in small and former isolated municipalities.

Keywords: Inter-municipal cooperation, local public spending, difference in differences.

3.1 Introduction

In the past twenty years, several countries have reverted from the decentralization policies of the end of the 20th century. The main justifications of these re-centralization policies is to benefit from economies of scale in the production of local public services, to internalize spillover effects among cooperating municipalities and to reduce tax competition. However, existing empirical evidence on the ability of inter-municipal cooperation to meet these goals is mixed (see e.g. [Bel and Sebö, 2021](#) for a recent review).

In the Emilia Romagna region for instance, [Ferraresi et al. \(2018\)](#) find that being within an inter-municipal community reduces the total per capita current expenditures by around 5 percent, without affecting the level of municipal public services. This effect is shown to be persistent over time and to increase up to six years after entrance. In France on the other hand, [Breuillé et al. \(2018\)](#) documents that fiscal cooperation created an increase in total tax rates. While they cite institutional inefficiencies, tax competition, spillover effects, and the increase in public services as potential explanations for this increase, there is a lack of evidence on the respective importance of these mechanisms.

Confirming or not that the inter-municipal union is effectively increasing the local efficiency in providing public services still needs to be investigated using more complete data on budget accounts. More specifically, there is a need to investigate the impact of the reform on these specific spending coming from the transferred competences from the cooperating municipalities to the community. Do cooperation and the related expected economies of scale reduce the overall spending in the field of competences that were transferred from the municipalities to the community? The basic decomposition of spending by nature (operating vs investment) does not allow to make such investigations. Since competences refers to some fields of action, which are sometimes transferred to the communities,

some informations on the range of competencies and the associated expenditure are needed.

The aim of this paper is to fill a gap in the literature, by considering a detailed database on spending and revenues made by French municipalities and by communities to explore the causal impact of inter-municipal cooperation on the expected economies of scale in the delivery of some local public services, which are transferred from the municipalities to the community.

We here exploit the characteristics of the French institutional setting to test the impact of inter-municipal cooperation on local budgets, and to isolate the effect of sharing specific missions from the overall effect of cooperation. Since 1999, the French government has favored the creation of inter-municipal jurisdictions based on large state grants, to solve the problem of “municipal fragmentation” in France. Inter-municipal communities are unions of several municipalities to enable collective financing and management of some local public services (essentially based on urbanism and economic development and planning). Currently, all French municipalities are grouped within larger jurisdictions (known as ‘Etablissements Publics de Coopération Intercommunale’ or EPCI).

To our knowledge, the originality of our paper is twofold. First, by using the decomposition of spending by function, we are able to determine the impact of inter-municipal cooperation on expenditures targeted to specific local policies. Second, by using data on transferred missions, we are able to estimate the effect of sharing specific policies conditional on cooperating, which allows us to disentangle the effect of transferring competences from modification of the tax regime.

We first find that total income from the municipality and the cooperation group increases substantially although municipal incomes fall. Overall, total per capita revenues increase by around €250. On average, per capita tax revenues

increase by €118 per capita on entry and then stay constant, while state transfers rise by €40. These results are consistent with (Charlot et al., 2015; Breuillé et al., 2018) who show that in France, fiscal cooperation is shown to lead to an increase of tax rates by reducing tax competition. Since tax revenues increase, we may wonder how this new income is spent after integration. Turning to spending, we observe that current spending increases by €220 per capita the year of integration, and stays constant afterwards. Self-financing increases slightly on entry (by €47) but the effect is not persistent, while investment raises by around €150 per capita. While we can not exclude that scale economies were achieved in the provision of some local public goods by inter-municipal communities, these results show that they were clearly dominated by some other mechanism(s).

One hypothesis for this lack of reduction in spending would be that, by imposing a new layer of government on top of already existing municipalities, inter-municipal cooperation actually created inefficiencies by multiplying personnel expenditures. While we find a significant increase of the share of wage bill in current expenditures of municipalities, we find no significant effect on the share of labor in total expenditures (municipality plus group) after entering an inter-municipal community. Further, we see no significant difference between the community's center¹ — which could more effectively transfer workers to the newly created group — and other cooperating municipalities. All in one, these results indicate that the increase in spending was not driven by labor costs and overlaps.

When investigating spending by function, we are able to measure the specific impact of cooperation on specific missions of the local government. Estimation results show that total (community and municipal) spending in urban policies and general services have increased while the other categories of total spending

¹The community's center, or *chef lieu* of the group is the head municipality in the cooperation group, in which the headquarters of the group are located.

remained stable after the creation of the inter-municipal community. Further, we investigate the effect of the transfer of seven missions to the cooperation group: public transit, garbage collection, social housing, social aid, road maintenance, economic policy (enterprise zones), and sports and cultural infrastructures. Conditional on already being a cooperation group, we find no negative effect of transferring any of these policies. This shows that, even when keeping the fiscal regime constant, groups that transferred these competences did not reduce their total spending relative to those who did not. Further, we find significantly positive and economically large effects of public transit, garbage collection and economic development. These three policies alone rationalize one fourth of the estimated total effect of cooperation. This is consistent with the result by [Tricaud \(2019\)](#) that cooperating municipalities saw a sharp increase in their probability to be connected to a public transport infrastructure, one of the main components of urban policy expenses.

Our results seem to indicate that the increase in spending following integration was driven mainly by an increased provision of specific public services that municipalities were too small to provide on their own. While this does not rule out the reduction in tax competition as a mechanism for the total increase in public spending, it does show that the zoo effect ([Oates, 1988](#)) is an important mechanism. This explanation was also given by [Frère et al. \(2014\)](#), who find no effect of cooperation on total spending on the time period 1994-2003, and a decrease in spending interactions. Considering for instance public transit, it does not make much sense for a small municipality to develop a network on its own, as this network would only span its own territory and the feasibility of longer trip would depend on the level of provision of nearby municipalities and their will and ability to coordinate. By transferring this service to a higher level of government that covers a larger territory — the cooperation group —

municipalities are able to internalize this externality and increase the service. Similarly for garbage collection, municipalities could for instance switch from a fixed collection point to proper collection services, while for economic policies they could decide to create common enterprise zones or services zones.

This article is also related to the recent existing literature on the effects of inter-municipal cooperation on local spending. Focusing mainly on the impact of inter-municipal cooperation at the aggregate level, the results are mixed (see e.g. [Bel and Sebö, 2021](#) for a recent review). [Reingewertz \(2012\)](#), [Baskaran et al. \(2016\)](#), and [Cobban \(2019\)](#) find some evidence of efficiency gains in Israel, Germany, and Ontario. Yet, there is no evidence of cost savings in Denmark, the Netherlands, or Italy ([Blom-Hansen et al., 2016](#); [Allers and de Greef, 2018](#); [Luca and Modrego, 2021](#)).²

The paper is organized as follows, Section 2 describes the institutional background, and Section 3 our data. Section 4 illustrate our empirical approach. Section 5 comments our findings. Section 6 concludes.

3.2 Institutional context

In France, inter-municipal cooperation increased greatly with the 1999 Chevènement law. When only 5,069 municipalities were part of an inter-municipal cooperation structure in 1993, all of them were members of a such cooperation structure in 2014.³

²[Ermini and Santolini \(2010\)](#) also investigate the impact of inter-jurisdictional agreements in Italy on the extent of spending interactions, focusing on specific categories of expenditures. They find that, for the two spending categories where the partnerships are very active – police and road maintenance – strategic interactions among jurisdictions in voluntary partnerships are lower than among isolated municipalities. This outcome suggests that the benefits of spillovers may be internalized in specific cases.

³In the December 16, 2010 law made it mandatory for French municipalities to join a cooperation group by 2014. Let us note that in 2009, 94% of French municipalities had already chosen to join one (due to state grants).

There are three jurisdictional forms for French communities, based on demographic criteria: the communauté urbaine (CU), with a minimum of 500,000 inhabitants, the communauté d'agglomération (CA), 50,000 inhabitants with a member municipality bigger than 15,000 inhabitants, and the communauté de communes (CC) that does not require any demographic criteria.

The share of the French population covered by one of these structures increased from 28% in 1993 to 100% in 2014. In recent years, there was a large majority of the most integrated forms of cooperation — CC and CA — those two categories accounting for 98% of French municipalities in 2014. However, given the sizeable differences in population between the municipalities choosing these two modes of cooperation, CCs and CAs only account for two thirds of the French population, while Métropoles make up the rest.

The jurisdictional form involves some compulsory responsibilities. For instance, a CC must take responsibility for at least one service in the category of “spatial planning”, and one in the area of “economic development and planning”. Similarly, CAs are required to take on one responsibility in each of four specific categories, and CUs are required to take responsibility for six. As a result, the most frequent services supplied by communities are economic planning and development, and garbage collection and treatment. This distribution of competences is related to the coordination between local policies and economies of scale, which are particularly important in network services.

Municipalities “democratically” decide which services will be delegated to the community among 14 categories (see Table A in the appendix). More precisely, every service considered – at the qualified majority – as being of “community interest” will be financed and managed collectively by the community. These decisions are made at the time that the community is formed, but changes are possible at any time, on the initiative of the municipal or community councils.

Functional cooperation allows for the cooperation entity to provide public services using its own taxes. The ways in which these taxes are set and interact with municipal taxes varies depending on the fiscal type of structure. French law allows for three different types of local business tax (taxe professionnelle): a single tax regime (fiscalité unique), an additional regime (fiscalité additionnelle) and a zone-specific regime (fiscalité de zone). The single tax regime is mandatory for CA establishments, and optional for CC and CU. In this setting, cooperating municipalities completely transfer their ability to levy the local business tax to the new cooperation entity. This gives rise to a unique business tax over the territory covered by the cooperating municipalities. At the opposite side of the spectrum are the additional cooperation groups. In this configuration, municipalities still decide freely on their property tax, while the cooperation structure is free to set an additional property tax rate, that applies uniformly to all the municipalities of the group. These communities levy 20% of the total tax revenues of the municipal block. Among them, 73% chose to transfer at least parts of their fiscal autonomy by choosing a single tax or a zone-specific system.

3.3 Data

We leverage accounting data for French municipalities and their groups over the 2000-2014 period.⁴ More precisely, we merge three sources of data. The first one (*comptes des collectivités*), for spending and revenues at the municipal level, is exhaustive from 2000 to 2014. The second one (still from the *comptes des collectivités*), for spending and revenues at the group level, is exhaustive on the 2007 to 2014 period. The third one, for functional accounting,⁵ is limited

⁴Data is actually available until 2019, but later years are not informative in our DiD setting because by 2015 all municipalities are treated.

⁵This dataset was provided by Brice Fabre (Fabre, 2017)

to municipalities with more than 3500 inhabitants and available from 2002 to 2011. Finally, we also gather data on the specific missions that were transferred to the cooperation group over the years. This data comes from the *BANATIC* database, that is available from 2007 to 2019 and exhaustive.

Combining these sources of data gives us three main estimation samples. The first one (Sample A), gathers all municipalities that entered a cooperation group after 2000, from 2000 to 2014. The second one (Sample B), gathers all the municipalities that cooperated after 2007. With this data, our dependant variable is total spending from the municipality plus the group. Before cooperation, this is simply municipal spending, so that when we restrict our sample to municipalities that cooperated after 2007 we can actually observe total spending from 2000 to 2014. These extra pre-treatment years can be used to increase the power of pre-trend tests. As discussed in [de Chaisemartin and D’Haultfoeuille \(2020\)](#), the estimation of the l -th dynamic effect requires to test parallel trends for the $l + 1$ last pre-treatment periods. As our data only allows us to estimate 5 years of post-treatment dynamic effects, we restrict Sample B to the 2001-2014 range, which allows us to exploit all of the available information in testing the parallel trends assumption up to 6 years before the treatment. Sample C gathers municipalities with a population greater than 3500 inhabitants that started cooperating after 2002, from 2002 to 2011. Finally, for the estimation of the effect of transferring a particular mission to the group, we adopt a diff-in-diff strategy comparing cooperating municipalities that do transfer a mission to those who don’t. Since the data on competences is available since 2007, we gather in sample D all the municipalities that are part of a cooperation group since before 2007, and we focus the estimations on the 2007 to 2019 period.

Table 3.3.1 describes our main variables at the municipal level as well as the cooperation status of municipalities over the three samples for municipalities

Table 3.3.1: Descriptive statistics over the three samples

	Sample A		Sample B		Sample C		Sample D	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
<i>Municipality only, before cooperation</i>								
Total revenues	915.10	1226.87	1099.27	1694.70	1376.59	685.71		
Taxes	415.44	642.85	518.69	877.06	799.79	470.01		
Transfers	199.38	178.91	226.66	207.83	264.47	133.21		
Total current	706.56	948.27	844.95	1311.05	1205.34	603.54		
Wage bill	209.29	219.63	248.89	271.85	545.17	258.18		
S.-f. capacity	138.54	424.87	171.42	575.97	94.78	175.63		
Investment	399.91	801.72	473.58	946.44	370.59	336.26		
<i>Total (group plus municipality), after cooperation</i>								
Total revenues			1436.56	1719.45	1533.57	511.39	1266.89	680.19
Taxes			695.25	1082.37	851.65	332.98	631.51	470.76
Transfers			289.77	231.05	321.02	108.49	260.70	164.41
Total current			1138.55	1293.89	1343.43	452.51	1041.73	566.34
Wage bill			348.73	334.00	597.31	219.10	348.19	211.80
S.-f. capacity			211.51	569.25	129.09	158.79	162.06	270.28
Investment			606.87	1092.71	469.40	269.26	499.52	583.44
Population	1400.11	5971.35	1185.04	3600.80	13021.21	14952.23	1635.96	9372.36
Cooperate	0.73	0.44	0.31	0.46	0.58	0.49	1.00	0.00
Number of observations	254796		42429		5921		364339	
Number of groups	1322		625		298		2354	

Descriptive statistics of main budget variables. Sample A: all municipalities that entered a cooperation group after 2000, from 2000 to 2014. Sample B: all municipalities that entered a cooperation group after 2007, from 2001 to 2014. Sample C: municipalities with a population greater than 3500 inhabitants that entered a group after 2002, from 2002 to 2011. Sample D: all municipalities that entered a group before 2007, from 2007 to 2019. All variables in Euros per capita. Cooperate is a dummy equal to one if the municipality is a member of a cooperation group in a given year.

with and without a cooperation group. All accounting variables are expressed in Euro per capita. Sample A has 254,796 observation pooling 14 years of data, corresponding to the 18,200 municipalities that entered a cooperation group after 2000. In total, they enter 1,322 distinct cooperation groups.⁶ Their average population is 1,400 inhabitants. Sample B on the other hand has 42,429 observations over 13 years, corresponding to the 3,264 municipalities that entered a cooperation group after 2007. Because on average big municipalities started cooperating earlier, they are relatively smaller than their counterpart in population A (1,185 inhabitants against 1,400). They also tend to have a bigger budget before cooperation, as they spend more per capita (€844.95 against €706.56, receive more taxes (€518.69 against €415.44) and invest more (€473.58 against €399.91). Finally, sample C only contains 5,921 observations, corresponding to the 657 municipalities with a population of more than 3,500 inhabitants that entered a cooperation group after 2002. Before cooperation, they have higher per capita revenues (€1376.59) and current expenses (€1205.34) than the two other groups, but lower investments (€370.59).

Table 3.3.1 also describes, for samples B and C, the sum of the per-capita revenues and spending of the municipality and the group, for cooperating municipalities. In both samples, total current expenditures on average higher than their municipal counterparts (by €293.6 in Sample B and €138.09 in sample C). As such, these descriptive statistics go against the realization of strong economies of scale that would have allowed to reduce total spending. We provide more rigorous evidence in that direction in the next sections.

We also supplement these data with spending data organized by function. There are nine functions in total, ranging from urban planning to sports in-

⁶Over the years, some municipalities switched groups and some groups merged, so that group id may change over the years for a given municipality. The number of distinct groups is counted using the 2014 ids.

Table 3.3.2: Descriptive statistics, current expenditures by function

	Total		Before coop.		After coop.	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Total	1138.77	458.30	1125.40	544.91	1148.64	381.72
General	438.60	218.95	434.96	245.85	441.29	196.74
Urban	225.15	130.61	212.89	146.26	234.20	116.92
Culture	64.53	51.40	61.66	54.41	66.66	48.95
Economic	21.92	46.28	23.13	58.19	21.03	34.94
Education	147.44	60.03	145.97	62.55	148.53	58.09
Family	46.30	52.50	44.55	50.90	47.59	53.63
Housing	5.21	12.24	6.25	15.63	4.43	8.88
Security	45.60	43.80	49.24	53.54	42.92	34.66
Social	36.35	42.23	39.77	44.81	33.84	40.04
Sports	107.66	69.34	106.99	77.10	108.16	63.01

Descriptive statistics of the functional spending data over Sample C: municipalities with a population greater than 3500 inhabitants that entered a group after 2002, from 2002 to 2011. Data represents total spending aggregating municipal and group level data. All variables are in Euros per capita.

frastructures. More detail on each category can be found in appendix. We describe total (municipal plus group) spending over all of these functions in Table 3.3.2, over the entirety of sample C, and specifically for cooperating and non-cooperating municipalities. First, we note that the first spending category is "general spending" (€438.6 per capita), followed by Urban policies (€225.15), Education (€147.44) and Sports and youth (€107.66). Urban policies groups all the "network" systems (like tap water, sewage systems and public transport), as well as garbage collection, road maintenance and urban renewal. Education concerns the maintenance of school buildings, and extracurricular activities and accommodations. Teachers and school employees are paid directly by the State. Finally, Sports and youth expenditures group the expenditures on stadiums, swimming pools and other outdoors infrastructures, as well as subventions to sports and youth clubs.

Comparing non-cooperating to cooperating municipalities, we can see a modest increase in total spending, that seems to be driven mainly by general

expenditures, urban and cultural policies, while some categories of spending such as security and social policies appear to decrease slightly.

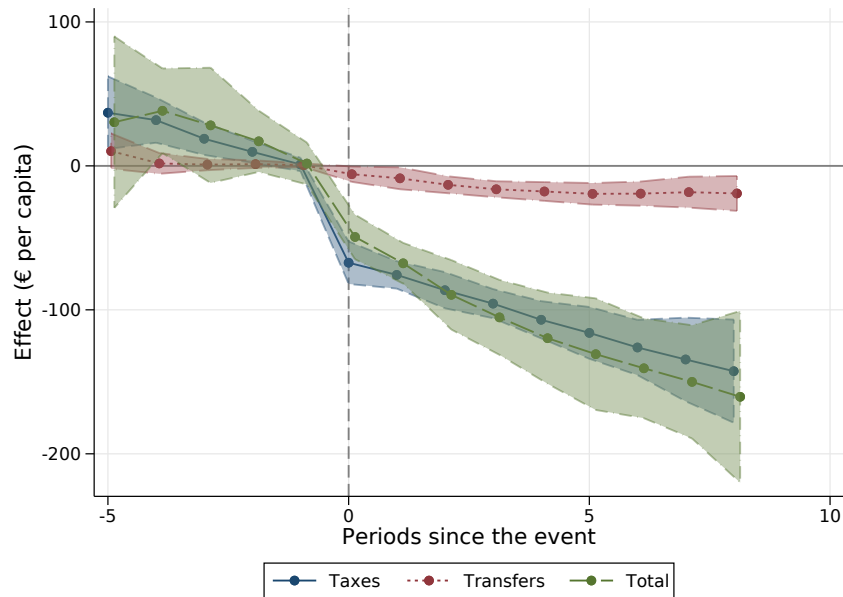
3.4 Results

3.4.1 Municipal budget

We estimate the effect of cooperation by exploiting the staggered adoption of cooperation. We use the estimator of de Chaisemartin and D’Haultfoeuille (2021a), which is robust to treatment heterogeneity, but we do not address potential selection into treatment. This does not seem to be a problem however, as placebo tests for pre-event trends pass for all our estimations. Further, focussing on taxes, Breuillé et al. (2018) reports instrumented coefficients that are remarkably close to the raw DiD estimates. Our main specifications concern total revenues, investment, wage bill and current expenditure, all per capita. In this section, we use the full sample of municipalities that started cooperating from 2000 to 2014 (sample A).

First, in Figure 3.4.1, we show that the results by Breuillé et al. (2018) on municipal tax revenues still hold when using the estimator of de Chaisemartin and D’Haultfoeuille (2020) and with our extended time coverage. As municipalities transfer their competences and set their taxes on the same fiscal basis as the cooperation group, they see their fiscal revenues go down. The instantaneous effect on tax revenues is €67 per capita (18.1% of the average before cooperation) and goes down to €143 per capita (38.5%) eight years after the event, although tax revenues were on a significant pre-trend two years and more before the treatment which implies that long run effects should be taken with caution. State transfers also go down substantially. The instantaneous loss in state transfers is €6 per capita (3%) and stabilizes at €19 (10%) five years after

Figure 3.4.1: Effect of cooperation on municipal revenues.



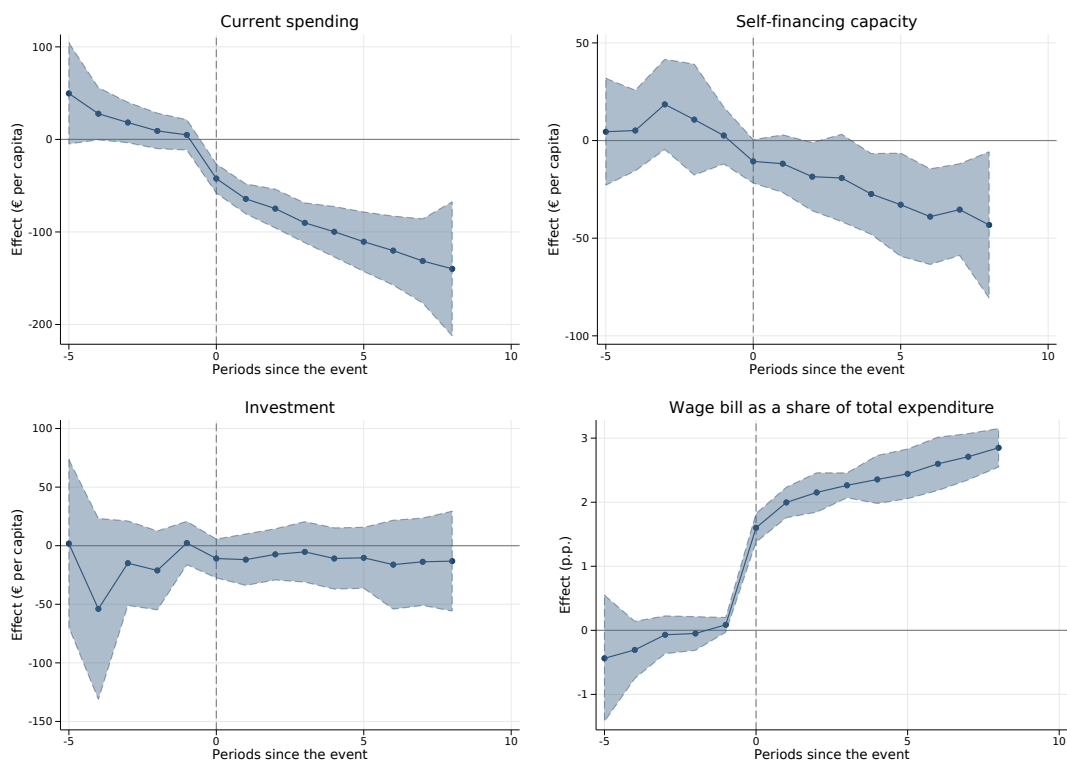
Effect of entering a cooperation group on municipal revenues. Estimations on all municipalities from 2000 to 2014 (sample A).

treatment. Turning to total municipal revenues, they go down by €49 per capita (5.8%) the year of the treatment to €160 (18%) eight years after joining the group.

Turning to spending, Figure 3.4.2 shows the effects of cooperation on current expenditures, cash flows, investment and the share of wage bill in current expenditures. As depicted in the first panel, the reduction in revenues is not entirely matched by the reduction in current expenses, that go down by €36 per capita (a 6.3% reduction w.r.t. average before entry) the first year, and up to €127 after eight years. This translates (panel 2) into a reduction of the self-financing capacity of municipalities, but has no significant (although the point estimates are negative, panel 3) on investments.

Interestingly, wage bill decreases proportionately less than the rest of current expenditures, leading to a raise in the share of wages in total expenditures

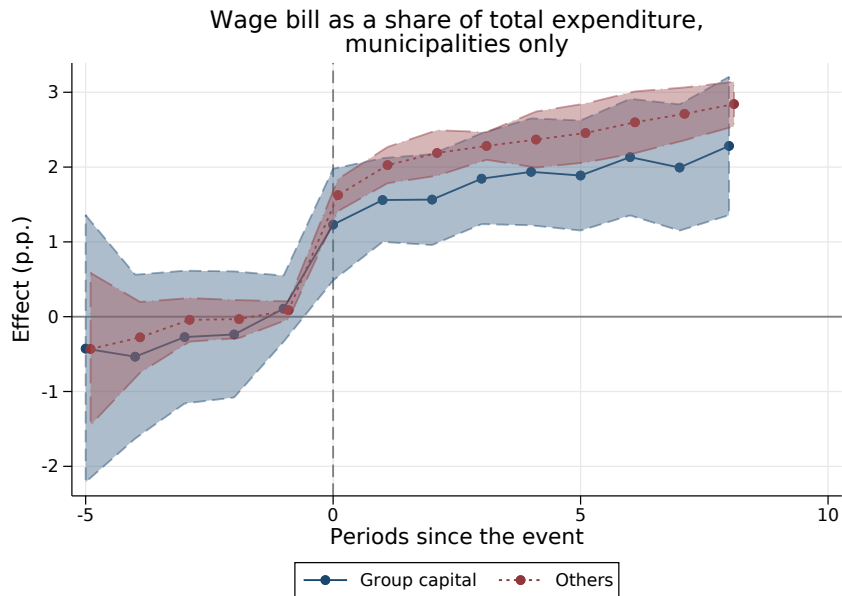
Figure 3.4.2: Effect of cooperation on municipal spending.



Effect of entering a cooperation group on municipal spending. First panel is total current expenditures, second is cash flows, and third and fourth are respectively investments and the share of wage bill in total current expenditures. Sample A.

(panel 4) of 2.9 percentage points (from a baseline of 29.26% before entry) after eight years. This increase in the share of wages in the production function of local services could come either from a change in the production function of municipal services or from rigidities in the adjustment of labor force. Public services production could change either because municipalities focus their supply on different services that are more labor intensive than others, or because they reduce their total output and the labor intensiveness of public services production decreases with production size. On the other hand, civil servant jobs are highly protected, and it could be that municipalities face rigidities when they try to layoff civil servants or transfer them to the cooperation group.

Figure 3.4.3: Effect of cooperation on the share of wage bill in current expenditures.

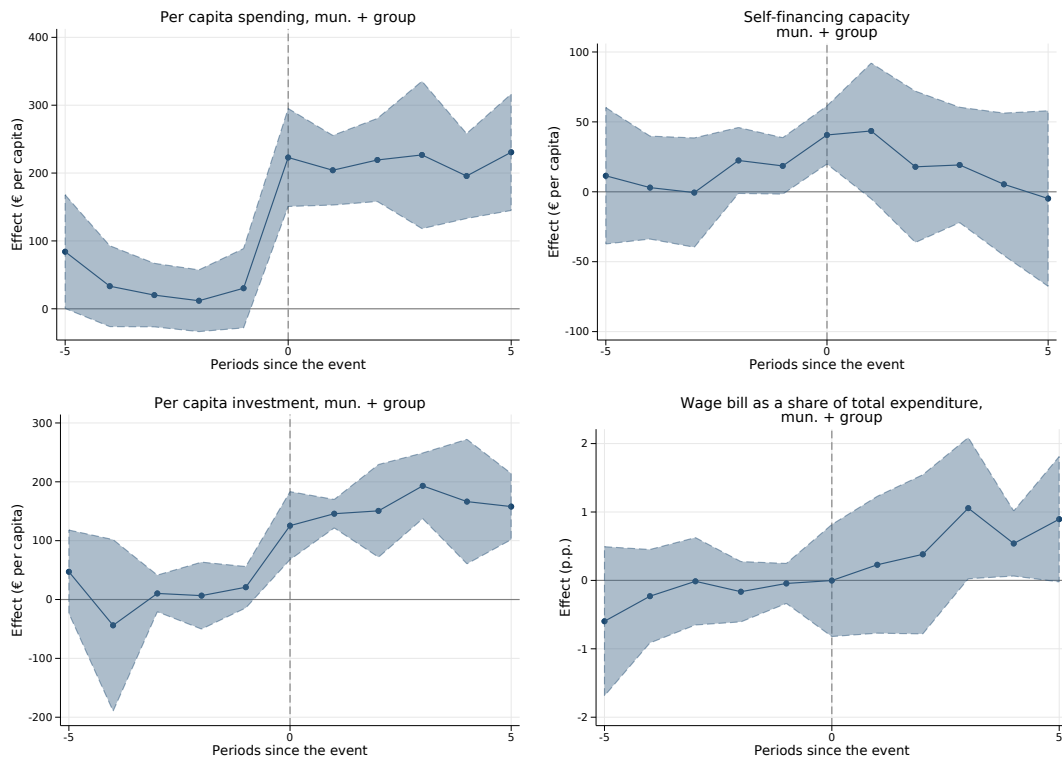


Effect of entering a cooperation group on the share of wage bill in total current expenditures, for group capitals and for other municipalities. Sample A.

This second explanation seems unlikely for two reasons. First, the share of wage bill does not decrease to its baseline level, even after eight years of being part of a cooperation group. If civil servants were resisting transfer or if municipalities had troubles laying them off, this effects should not be permanent. After a few years, municipalities should manage to bring their wage bill back down by not replacing the workers who voluntarily move or retire. Second, we also try to indirectly test the role of rigidities in workers transfers by comparing the effect of cooperation on the group capital to the one on regular members. When transferring civil servants in another administration, they cannot directly refuse the transfer but they can make it more costly by asking for moving compensations if their new place of work is in a different municipality than the former one. As the offices of the group are located in the capital municipality,

and very often in the same or an adjacent building to the mayors office of the capital, these moving costs should be lower for the capital of the group. More precisely, we test this hypothesis by running two separate DiD event studies, one restricted to municipalities that will become or currently are the capital of their group, and another one on municipalities that are not and will never be. As we show in figure 3.4.3, although the point estimates are slightly lower, group capitals still experience an increase in wage bill share and there is no significant difference between the effect on the capital and the effect on other municipalities, discrediting transfer costs as an explanation.

Figure 3.4.4: Effect of cooperation on total spending.



Effect of entering a cooperation group on total (group + municipality) spending. First panel is total current expenditures, second is cash flows, and third and fourth are respectively investments and the share of wage bill in total current expenditures. Estimations on all municipalities that entered a cooperation group after 2007 (sample B).

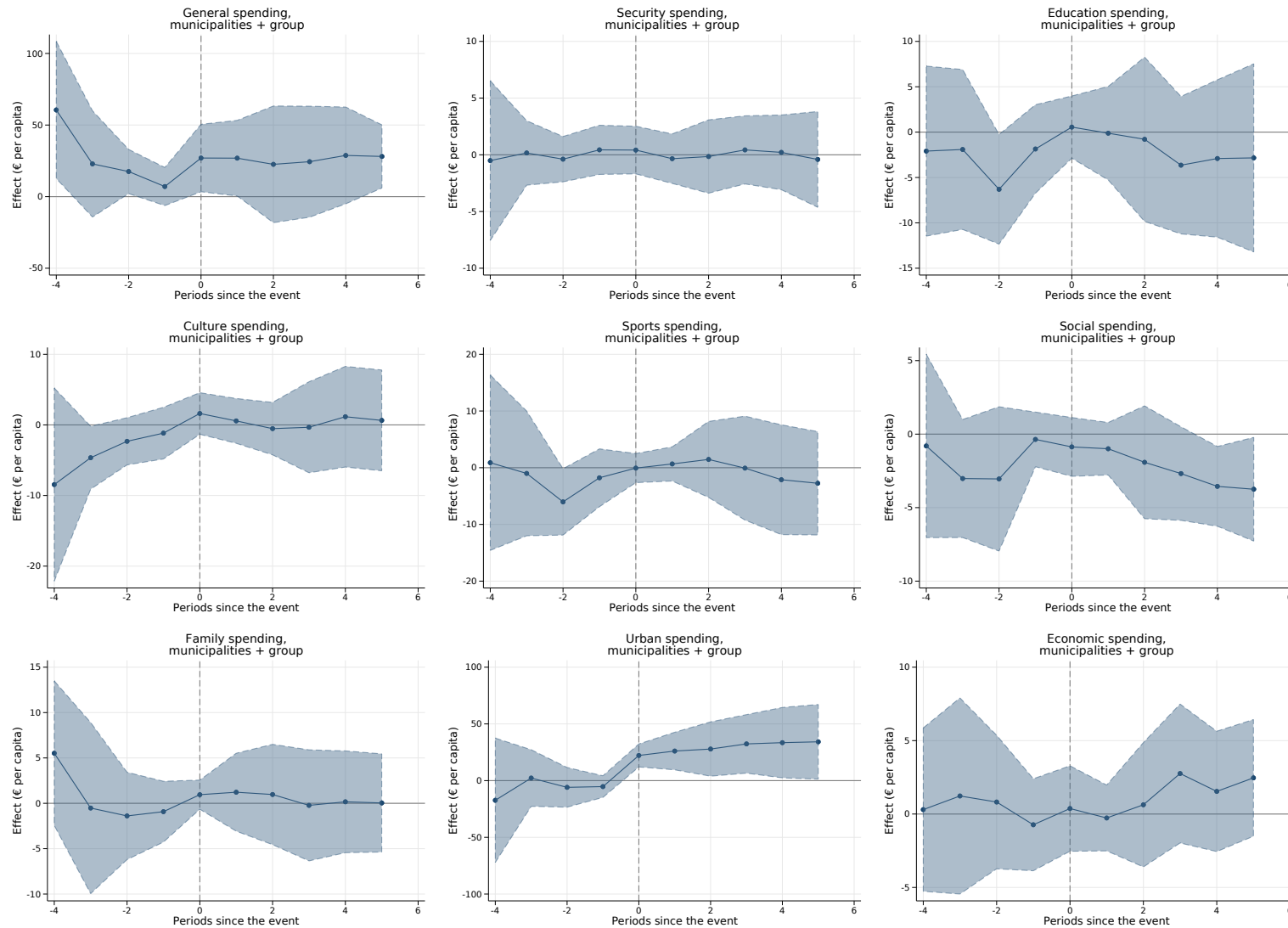
3.4.2 Effects at the municipal block level

In this subsection, we look at the impact of cooperation on total revenues and spending from both the cooperation group and the municipality. We construct these variables by summing over per-capita expenses at the municipal and the group level, which corresponds to assuming a repartition of group expenses that is proportional to the population share of the municipality in the group total.

First, consistent with Breuillé et al. (2018) and Tricaud (2019), although municipal incomes fall, total income from the municipality and the cooperation group increases substantially (Figure 3.B.1 in appendix). On average, per capita tax revenues increase by €118 per capita on entry and then stay constant, while state transfers rise by €40. All in one, total per capita revenues increase by around €250. This increase, mainly driven by tax transfers, corresponds to 21% of the average revenue of municipalities the year before cooperation.

Turning to spending, this increase in revenues is spent in its entirety. As shown in Figure 3.4.4, total spending increases by €220 per capita (24% of the pre-treatment average) the year of integration, and stays constant afterwards. Self-financing increases slightly on entry (by €47) but the effect is not persistent. Investment nonetheless raises by around €150 per capita, a 33% increase with respect to the pre-treatment average. Further, we see no significant effect on the share of labor in total expenditures on entry, and only a small and slightly significant effect after three years. This lack of effects at the group level, particularly at the entry year goes to reinforce the assertion of the previous section that the effect observed on municipalities is probably not driven by the cost of transferring workers, but by more structural changes to the production function of municipal public services.

Figure 3.4.5: Effect of cooperation on total spending, by function.



Effect of entering a cooperation group on total (group + municipality) spending. First panel is total current expenditures, second is cash flows, and third and fourth are respectively investments and the share of wage bill in total current expenditures. Estimations on municipalities with a population greater than 3500 inhabitants that entered a cooperation group after 2002 (Sample C).

3.4.3 Spending by function

To further investigate the effects of cooperation on local spending, we also gather data on spending by function. In these data, every expense from the local government is categorized into one of ten functions. We give a description of each of these categories in appendix. Due to data limitations, we restrict the analysis to municipalities with more than 3500 inhabitants that entered a cooperation group after 2002 (sample C).

In Figure 3.4.5, we report the effect of entering a cooperation group on each category of spending. The only two functions for which cooperating leads to a significant increase in spending are general services and urban policies. For all other services, the effect is null, and even negative for social policies.

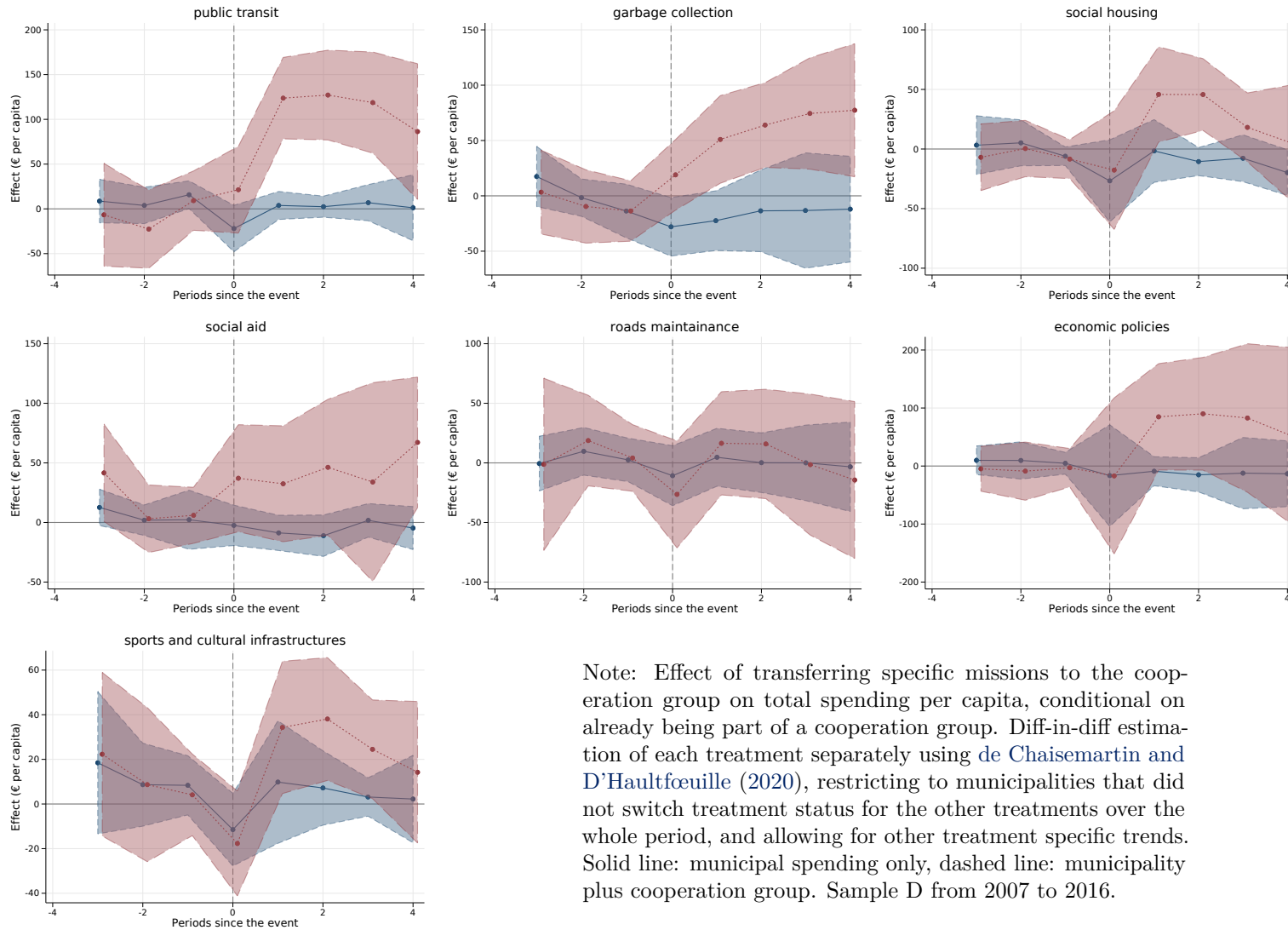
While this result indicates that the increase in spending when joining a cooperation group is concentrated on urban policies (mainly public transit and road maintenance), this fact alone does not allow us to conclude on the role played by the provision of those particular public goods in the global increase in spending. Indeed, it could for instance still be caused by reductions in tax competition.

To further investigate the role played by particular public services on total expenditures, we investigate in the next subsection the effect of transferring specific missions to the cooperation group, conditional on already belonging in a group.

3.4.4 Effect of transferring missions

In this subsection, we examine more closely the spending of local governments when they deepen their cooperation by transferring and additional competence from the municipality to the cooperation group. Because our data on functional

Figure 3.4.6: Effect of transferring missions total spending, controlling for other functions



Note: Effect of transferring specific missions to the cooperation group on total spending per capita, conditional on already being part of a cooperation group. Diff-in-diff estimation of each treatment separately using [de Chaisemartin and D'Haultfœuille \(2020\)](#), restricting to municipalities that did not switch treatment status for the other treatments over the whole period, and allowing for other treatment specific trends. Solid line: municipal spending only, dashed line: municipality plus cooperation group. Sample D from 2007 to 2016.

accounts is thin and only spans the years 2002 to 2012, while our data on competences starts in 2007, we do not look at the specific impact on spending by function, but focus on total current expenditures instead.

More specifically, we restrict the estimation to municipalities already cooperating in 2007 and estimate the effect of transferring the management of some particular missions to the cooperation group. This way, we are able to estimate the additional spending caused by deepening the integration of local public good provision net of the effect of tax competition that happens when municipalities start sharing their tax base with the group. We focus on public transit, garbage collection, social housing, social aids, road maintenance, economic policies and sports and cultural infrastructures. We chose these competences as they cover the main missions of French municipalities and cooperation groups.

In a first step, we estimate the raw effects of each treatment separately. The problem however is that these treatments do not happen randomly but are positively correlated, because when municipalities choose to deepen their often vote several transfers at the same time. Indeed, in Table 3.B.1 we report the results of two way fixed effects regressions of each treatment variable on the other treatments. We see that the coefficients are positive and often significant. As explained by [de Chaisemartin and D'Haultfoeuille \(2021b\)](#), there is no clear cut way to control for several treatments that is robust to dynamic effects and heterogeneous treatment effects when the treatments do not always happen sequentially.

We implement two solutions to still try to estimate effects net of the other transfers. First, we compute diff-in-diff estimates robust to heterogeneous treatment effects following [de Chaisemartin and D'Haultfoeuille \(2020\)](#), restricting the sample to municipalities that did not change treatment status on the other treatment variables for the estimation period and allowing for different trends

in each treatment status. Therefore, we measure the effect of transferring one mission amongst municipalities that did not transfer any other mission during the period. Because a lot of municipalities deepened their cooperation in 2017, we restrict the sample to 2007-2016 and to those municipalities that kept other treatment status constant over this period, so that we do not lose too many observations.

Second, we run a traditional two-way fixed effects regression that includes all the treatments at the same time. Because we already have seven treatment variables we do not try to add dynamic effects to this specification. An additional concern for our estimation would be that transfers coincide with changes in the tax regime of the group, which would create reductions in tax competition that could drive changes in spending. We also report specification where we control for the tax regime of the group.

We report the result of the first estimates in Figure 3.B.2 in appendix. These estimations run regressions separately for each treatment without trying to control for their correlation. All the estimates are significantly positive, except for social aid that is positive but not significant. Interestingly, public transit and economic policies have the highest positive impact on spending, with point estimates around €100 per capita. Regarding municipal expenditures, they decrease slightly for some policies (garbage collection and roads maintenance), but the point estimates are low (less than €20 per capita) and not significant in the long run, although quite precisely estimated. This absence of reduction in municipal expenditures might be an explanation for the increase in total spending at the municipal bloc level.

Turning to our first control strategy, the effects of public transit and garbage collection stay positive and strongly significant, while the effect of the remaining competences become less clear. While the point estimates on economic policy

Table 3.4.1: TWFE regressions of total spending on mission transfer indicators

	Municipality plus group		Municipality only	
Public transit	94.58*** (9.172)	93.82*** (9.123)	8.690 (4.444)	8.752* (4.398)
Garbage collection	26.29** (10.07)	26.05** (10.05)	-20.63*** (6.104)	-21.02*** (6.151)
Social housing	7.132 (6.269)	2.689 (6.331)	-5.947* (3.017)	-7.399* (3.216)
Social aid	5.391 (8.722)	5.829 (8.666)	-5.546 (3.418)	-5.397 (3.380)
Roads maintainance	14.93 (8.142)	11.42 (8.063)	2.541 (3.711)	0.963 (3.802)
Economic policies	37.28*** (8.404)	36.68*** (8.406)	-3.145 (3.585)	-3.176 (3.586)
Sports & cultural	11.67 (6.927)	8.963 (6.819)	3.040 (4.009)	1.917 (3.900)
Observations	364339	364339	364339	364339
Tax regime dummy	No	Yes	No	Yes

Standard errors in parenthesis. Standard errors clustered at the cooperation group level. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Estimations on Sample D. All regressions include year and municipal fixed-effects.

stay stable, standard errors increase massively and they are no longer significant. Social housing still has a positive effect one and two years after entry, but it fades away after three years, and sports and cultural infrastructure follow a similar pattern.

Our second control strategy yields very similar results. Public transit is the mission that yields the highest increase in spending, with an estimated increase of €94 per capita, followed by economic policies (€37) and garbage collection (€26), while social housing, social aid and road maintenance all have non-significant effects. Further, these results are robust to controlling This confirms the results

from the previous section that the increase in total expenditures is mainly driven by urbanism policies.

On average, the share of municipalities sharing these missions in sample C (municipalities that cooperated after 2007) is 22.8% for public transit, 93.8% for garbage collection and 21.5% for economic development. Assuming that the estimates in sample D generalize to sample D, these three competences alone are therefore responsible for a $0.228 \times 94 + 0.215 \times 37 + 0.938 \times 26 = 53.78$ Euro increase in total public spending, which corresponds to 25% of our estimated total effect of cooperation. This seems to indicate that the increased provision of specific public services that municipalities were too small to provide on their own was an important driver of the total increase in public spending. While this does not rule out the reduction in tax competition as a mechanism for the total increase in public spending, it does show that the zoo effect (Oates, 1988) is an important mechanism. Considering for instance public transit, it does not make much sense for a small municipality to develop a network on her own, as this network would only span her own territory and the feasibility of longer trip would depend on the level of provision of nearby municipalities and their will and ability to coordinate. By transferring this service to a higher level of government that covers a larger territory — the cooperation group — municipalities are able to internalize this externality and increase the service. This explanation is consistent with the results of Tricaud (2019) that the probability to be connected to a transport network increased strongly after joining a cooperation group. Similarly for garbage collection, municipalities could for instance switch from a fixed collection point to proper collection services, while for economic policies they could decide to create common enterprise zones or services zones. We would need additional data on the quantity of these services to test this interpretation.

3.5 Concluding remarks

In this paper, we show evidence that inter-municipal cooperation, instead of decreasing total spending through economies of scale, leads to a sizable increase in local public spending. Further, we argue that this increase does not seem to be driven by wage bill expansion.

Moreover, we show it was driven by urban policies and general services. By nature, these functions (public transportation, network maintenance) are prone to generating positive externalities whereby the marginal benefit of these services increases with the level of provision of neighboring municipalities. Exploring the specific effect of transferring the responsibility of some services to the group, we did not find any significant reduction in spending for any of the services we considered. Instead, we found significant and large positive effects for the transfer of public transportation, garbage collection and economic development, which are all services that could have seen an improvement in their quality following an enlargement of their provision zone.

While we can not exclude that scale economies were achieved in the provision of some local public goods by inter-municipal communities, they were clearly dominated by either an increase in public services or reductions in tax competition. Our results add evidence in favor of the second explanation, whereby the provision of new public services for rather small municipalities drove a sizable share of the increase in local public spending following cooperation. To further investigate the existence or not of the economies of scale, at the community's level we plan to complement this study using data on services quantities and use the effect of the French reforms in 2010 and 2015, which mandated mergers between former existing inter-municipal communities if their population was too small, to explore the relationship between group size and spending. Moreover, we can also not rule out an increase in the cost of providing some of the services,

due to some forms of negative economies of scale, for instance because with small municipalities, the cooperation group is by essence fragmented, which can decrease the cost effectiveness of providing some services [Hortas-Rico and Solé-Ollé \(2010\)](#). A measure of territorial fragmentation should therefore be included in this next step of the analysis.

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3.A Definitions

0. General: IT, administrative and support services, cemeteries, and in general all expenses that cannot be filed elsewhere;
1. Security: Police, firefighters and prevention programs;
2. Education: Schools and associated extracurricular activities and services (sports, health, school canteens, accommodations and boarding and school buses);⁷
3. Culture: public libraries, theatres and museums, as well as financial support to cinemas, galleries, festivals, professional artists and amateur clubs;
4. Sports and youth: swimming pools, stadiums and other infrastructures for sports and outdoors activities, as well as youth clubs and day care centers (excluding preschools);
5. Social and health: mainly social policies such as foster cares, relief programs and professional insertion programs, as well as centers and infrastructures for the disabled. This category can also include a small share of health infrastructures such as dispensaries, maternity wards and abortion centres, but public hospitals and emergency rooms are financed by higher levels of government and the public health insurance system;⁸

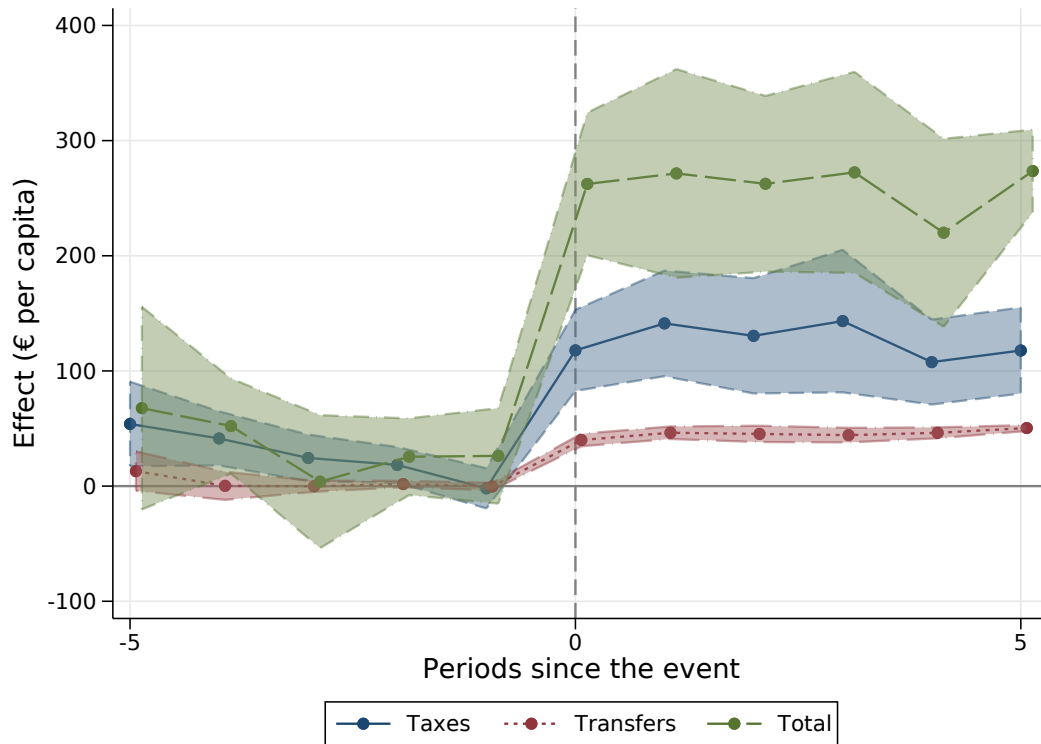
⁷It should be noted however that in France, teachers and school employees are paid directly by the ministry of education, and municipalities only manage primary schools. They mainly finance building renovations and extra-curricular activities. Higher levels of education are managed either by the county, the region or the state, although municipalities might co-finance some extra-curricular activities and services.

⁸For instance in 2008 10% of this category came from health services at the municipal level and 3% at the group level, while the remaining were social services (OFGL, 2010).

6. Family: services for senior citizens (from nursing homes to senior citizen's clubs), family discounts of municipal services, and daycare centers and preschools.
7. Housing: aids to social housing organizations and construction companies;
8. Urbanism: tap water and sewage system, garbage collection, cleaning services, public transport, road maintenance, public parks, urban renewal and forestry and river management as well as environmental conservation policies;
9. Economic policies: open markets and business assistance.

3.B Additional results

Figure 3.B.1: Effect of cooperation on total revenues.



Effect of entering a cooperation group on total (municipality and group) per-capita tax revenues, state transfers and total revenues. Estimations on all municipalities that entered a cooperation group after 2007 (sample B).

Table 3.B.1: Correlation between transfer treatment variables

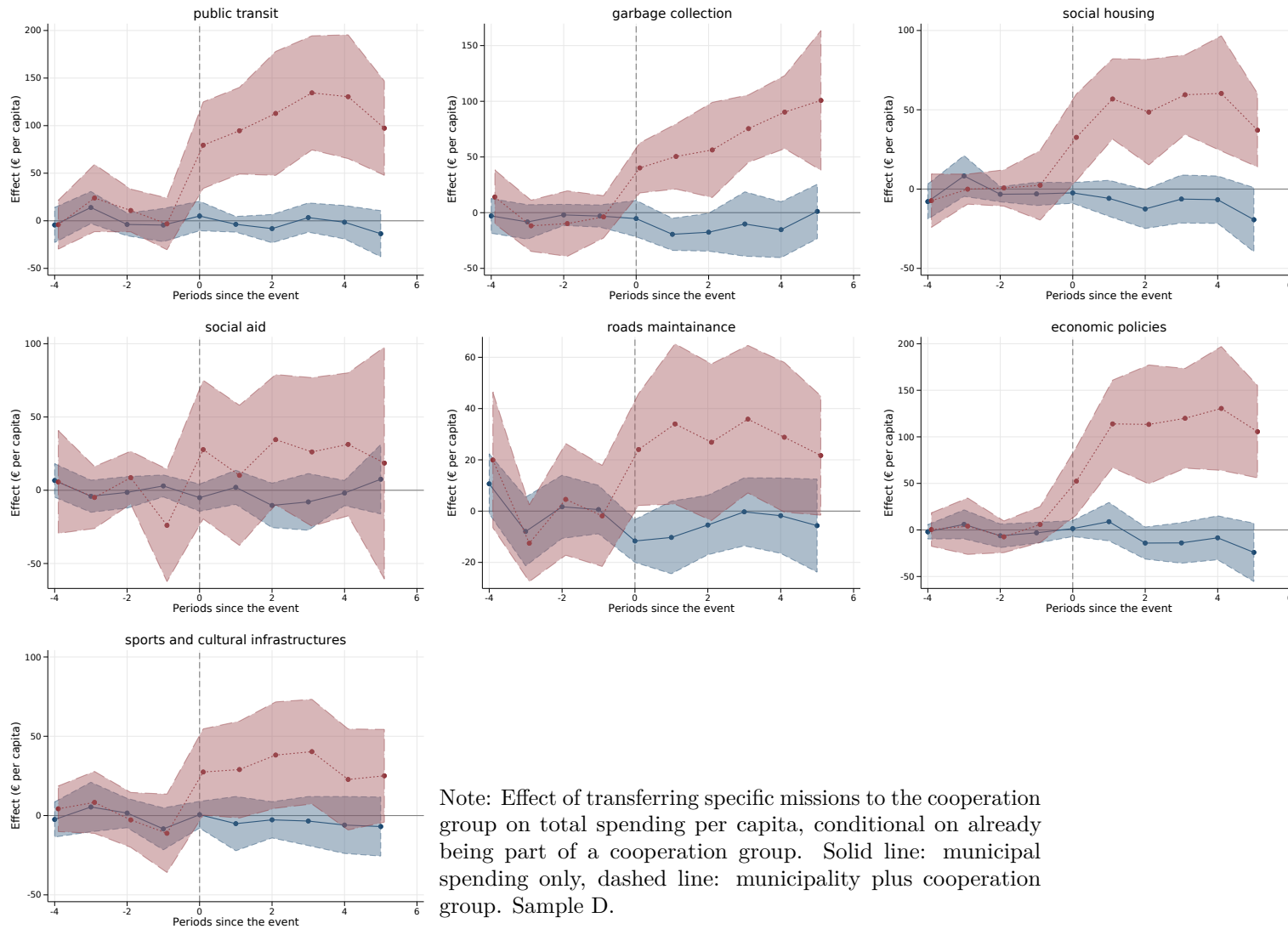
	PT	GC	SH	SA	RM	EP	SC
Garbage collection	0.0420 (0.0259)		0.0265 (0.0245)	0.0202 (0.0195)	0.0355 (0.0209)	0.0227 (0.0232)	0.101*** (0.0272)
Social housing	0.117*** (0.0162)	0.0125 (0.0115)		0.0202 (0.0146)	0.0757*** (0.0167)	0.129*** (0.0172)	0.0956*** (0.0172)
Social aid	0.0526* (0.0215)	0.0150 (0.0144)	0.0317 (0.0231)		0.0595** (0.0211)	0.0414 (0.0212)	0.0535* (0.0228)
Roads maintainance	0.0342* (0.0159)	0.0217 (0.0125)	0.0980*** (0.0214)	0.0491** (0.0172)		0.0413* (0.0164)	0.0917*** (0.0202)
Economic policies	0.360*** (0.0213)	0.0149 (0.0152)	0.180*** (0.0235)	0.0367* (0.0187)	0.0444* (0.0177)		0.0526** (0.0200)
Sports & cultural	0.0310* (0.0153)	0.0520*** (0.0137)	0.105*** (0.0188)	0.0373* (0.0158)	0.0775*** (0.0172)	0.0413** (0.0159)	
Public transit		0.0303 (0.0186)	0.178*** (0.0251)	0.0512* (0.0208)	0.0404* (0.0189)	0.395*** (0.0246)	0.0433* (0.0213)
Observations	364339	364339	364339	364339	364339	364339	364339

Standard errors in parentheses

TWFE regressions. Errors clustered at the group level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 3.B.2: Effect of transferring missions total spending.



Abstract

This PhD thesis studies the links between spatial inequalities, local public policies and institutional fragmentation. The first chapter quantifies the impact of urban transport policies on income inequalities within cities. Using a spatial equilibrium model calibrated on the Paris urban area, this chapter studies two transport policies: i) the Regional Express Rail (RER), ii) a potential ban on cars in the city center. Model simulations show that the RER decreased spatial income inequalities at large, and more particularly the inequalities between the inner Paris and the suburbs. Further, the model suggest that banning cars would not necessarily increase inequalities. Focusing on the impact on commuting costs, the policy would increase inequalities between peripheral municipalities and decrease inequalities between Paris and its suburbs at the cost of a sizable welfare loss. Taking into account its effects on amenities, the policy could have positive welfare effects, but would then increase spatial inequalities and it would benefit more the affluents. In the second chapter, we explore the effects of inter-municipal cooperation on households localization and income. We find a small but positive effect on incomes, but no effect on populations. Finally, in the third chapter we study the impact of inter-municipal cooperation on the budget of French municipalities. We find that cooperation led to an increase in total spending that cannot be attributed to wage bill expansion. Instead, it comes from urban policies and general spending. Looking at the transfer of specific missions to the cooperation group, we show that a quarter of this effect can be explained by the transfer of public transit, economic aid and garbage collection. Overall, cooperation allowed to increase the supply of these services in municipalities that were too small to provide them on their own.

Keywords: Spatial inequalities, segregation, public transit, local public spending

Résumé

Cette thèse étudie les liens entre inégalités spatiales, politiques publiques locales et organisation du territoire. Le premier chapitre quantifie les effets des politiques de transport urbain sur les inégalités de revenus dans les villes. À l'aide d'un modèle d'équilibre spatial calibré sur l'aire urbaine de Paris, il se concentre plus particulièrement sur i) le RER, ii) une potentielle interdiction de circuler en voiture dans Paris. Les simulations du modèle montrent que le RER a permis de réduire les inégalités de revenus dans l'aire urbaine, et plus particulièrement entre Paris et la banlieue. De plus, l'interdiction de circulation n'augmenterait pas nécessairement les inégalités. En ne prenant en compte que les effets sur les temps de trajet domicile-travail, cette politique réduirait même les inégalités entre Paris et la banlieue, au prix d'une perte de bien-être social. En prenant en compte ses effets sur les aménités, elle pourrait avoir des effets positifs sur le bien être social, mais dans ce cas elle augmenterait les inégalités spatiale et bénéficierait majoritairement les cadres. Dans le second chapitre, nous étudions les effets de la coopération intercommunale sur la localisation des ménages et leurs revenus. Nous trouvons un effet faible mais significatif sur les revenus, mais aucun effet sur les populations. Enfin, dans le troisième chapitre nous étudions les effets de l'intercommunalité sur les budgets des communes. Nous trouvons une augmentation de la dépense, tirée par les dépenses d'urbanisme et les dépenses générales. En étudiant les transferts de compétences, nous montrons qu'un quart de l'augmentation des dépenses peut s'expliquer par le transfert des transports urbains, de l'aide économique et de la collecte des ordures ménagères. Elle est donc, au moins en partie, le résultat d'une augmentation de l'offre de certains biens publics que les communes, du fait de leur petite taille, ne pouvaient pas offrir seules.

Mots Clés : Inégalités spatiales, ségrégation, transport public, dépense publique locale