This Town Ain't Big Enough? Quantifying Local Public Goods Spillovers

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JEL Codes: D160, H41, H71, H72, H73, R13
Keywords : Local Public Service, Spillover Effect, Spatial General Equilibrium, Tiebout, Welfare Economics, State Government Subsidies

Preliminary Version

This Town Ain't Big Enough? Quantifying Local Public Goods Spillovers [a]

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Abstract

Despite long-standing theoretical interest, empirical attempts at investigating the appropriate level of decentralization remain scarce. This paper develops a simple and flexible framework to test for the presence of public good spillovers between fiscally autonomous jurisdictions and investigate potential welfare gains from marginal fiscal integration. We build a quantitative spatial equilibrium model of cities with mobile households and endogenous local public goods causing spillovers across jurisdictional boundaries. We show how one can exploit migration and house price responses to shocks in local public goods at different geographic scales to reveal the intensity of spillovers. Applying our framework to the particularly fragmented French institutional setting, we structurally estimate the model using a unique combination of administrative panel datasets on cities. Estimation relies on plausibly exogenous variations in government subsidies to instrument changes in the supply of local public goods. We find that public goods of neighboring cities account for approximately 89-96% of total public goods benefiting residents of the average French city. Finally, we simulate the effect of a reform increasing fiscal integration and find substantial welfare gains.

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1 Introduction

Take an economy divided into geographically distinct jurisdictions. Who should be providing local public services? Local governments or the central government? If local jurisdictions are tasked with providing public goods, what should be their boundaries? Since the seminal work of Tiebout (1956) and Oates (1972), academics have investigated the optimal balance of power between local and more centralized forms of government. Simply put, the political economy of centralized decision-making misallocates local public services. On the other hand, decentralization is inefficient because of spatial spillovers i.e. the extent to which a city's local public goods also benefit its neighbors[1]. Yet, there seems to be no consensus in practice about the optimal size and autonomy of cities and there remains substantial variation in local jurisdictional organization across western countries. Average city population is 4,300 in the EU compared to 16,000 in the US. Within the EU itself, there are large disparities between otherwise comparable countries. Average city density is similar in Germany (179 inh. per km^2), France (154 inh. per km^2) and Spain (177 inh. per km^2). However, with mean city population of respectively 7,100 and 5,800, German and Spanish jurisdictions are much larger than the average French municipality only home to 1,753 inhabitants.

Jurisdictional fragmentation has important welfare consequences. To illustrate these, let us consider three stylized channels. When spillovers are strong, local jurisdictions may under-provide local public services as they do not internalize their benefits to neighboring jurisdictions. In addition, cities may actively free-ride on neighboring cities' public goods, worsening the under-provision problem. Finally, spillovers create migration externalities. Residential choices influence the local political process providing public goods, thereby affecting neighboring cities' welfare. Policy and institutional solutions to remedy spillover inefficiencies typically include pigovian subsidies and boundary redefinition. While the former solution requires the tailoring of subsidies to spillover intensity, one simply needs knowledge of the presence of spillovers between jurisdictions of designated geographic areas to implement the latter.

Although a rich theoretical literature studies efficient fiscal federalism (see Oates (2005) for a review), empirical evidence on spillover inefficiency is scarce. There are indeed empirical and theoretical challenges to disentangle public good spillovers from other general equilibrium mechanisms. First, the difference between two cities in the level of public services provided by their neighbors may cap-

[1] Decentralization can be inefficient in many more ways e.g because of business tax competition. See Boadway and Tremblay (2012) for a review. We abstract from these considerations in the present paper.

ture differences in own residential and production fundamentals. Indeed, a productive and densely populated neighbor will typically provide a high level of public services, and high rents and densities in surrounding locations may just reflect spillovers between local labour markets or correlated productivity shocks. Second, spatial spillovers interact with fiscal externalities in intricate ways[2].

This paper revisits the local public good provision debate in a quantitative spatial equilibrium model. Our contribution is twofold. First, we develop a simple framework to test for potential welfare gains from arbitrary increases in the level of centralization of local public goods provision. We ground it on a location choice model borrowed from the urban economics literature that allows us to isolate public good spillovers from other mechanisms at play in equilibrium. The key ingredient is the nesting of fiscally autonomous jurisdictions in geographic areas within which one suspect there are cross-border spillovers. By studying migration and house price responses to local public good shocks first between jurisdictions within nests, then between such nests, one can reveal the presence of spillovers. Because these nesting areas can be made to encompass an arbitrary number of jurisdictions, our framework allows to repeatedly test for the presence of spatial spillovers until reaching the optimal jurisdictional fragmentation. To the best of our knowledge, this paper is the first attempt at taking a structural approach to fiscal decentralization. Second, we apply our framework to French data and provide new estimations of structural parameters that are key to the local public finance debate. In the much fragmented French context, we estimate strong spatial spillovers and significant fiscal externalities.

Our approach has two limitations. First, assessing the inefficiency cost of centralization is beyond the scope of the present paper. These costs typically stem from the interaction between centralized political frictions that tend to create winners and loosers, and heterogeneous local needs[3]. As such, we abstract from the taste heterogeneity motivating the standard Tiebout literature and do not account for interactions between local and central governments. Second, structural parameters may themselves be endogenous to local public goods e.g. to the development of regional transit.

We first develop a spatial equilibrium model of cities that draws on the seminal framework of Rosen (1974) and Roback (1982) and allows for endogenous wages, rents and local public good provision. We let households be potentially infra-marginal in their migration choices by introducing heterogeneous

[2]Fiscal externalities arise when public goods are not private goods. In this case, the costs of providing residents with a given level of public good benefits increase less than one for one with population. Denser cities typically provide more public goods for less taxes which creates an agglomeration force.

[3]See for example Carbonnier et al. (2008) for an attempt at assessing both the costs of centralization and decentralization.

preferences for cities. Our agents are otherwise homogeneous in skills and have identical preferences for public goods over private consumption. They vote for local taxes and a level of public services that will in turn affect equilibrium demand for cities. Most importantly, we allow for cross-border public good spillovers in a simple flexible structure that keeps the model amenable to reduced-form empirical analysis. Our model pinpoints key structural parameters related to spillovers, the rivalness of local public goods, preference for public services, household mobility and housing supply elasticity.

Home to around $35,000$ autonomous municipalities accounting for 38% of EU's total, France is a natural context in which to apply our framework. We first provide difference-in-difference (DiD) evidence on the impact of public good supply shocks on migration, housing consumption and house prices using comprehensive administrative datasets on French cities. We combine data covering local taxes and public spending, population, housing consumption, wages and house prices from 2000 to 2016. Our identification strategy exploits plausibly exogenous variation in investment-targeted subsidies to instrument changes in local public goods. Overall, we find significant migration responses and house price capitalization which we interpret as evidence that households are mobile, enjoy local public services and that housing supply is not inelastic in the medium run. However, we find that migration responses to public good shocks within groups of neighboring cities are smaller than when comparing such groups between them. We also estimate significant house price capitalization in the latter case and not in the former. In line with our theoretical framework, a candidate mechanism to explain these reduced-form results is the presence of spatial spillovers, rendering location decisions less relevant for the enjoyment of publicly provided amenities within groups of close-knit jurisdictions.

We then take our theoretical framework to the data and use a Generalized Method of Moments (GMM) to estimate the model's parameters. Our identifying moments build on the subsidy shocks used in our DiD models and harness underlying variation in housing supply elasticity across jurisdictions. We find significant cross-border spillovers. Public services in neighboring cities account for 89-96% of total public services benefiting a city's residents. Our estimates for public spending preference and housing supply elasticity lie within the range of the literature. Mobility of French households is much higher than current estimates for the US, which reflects that the considered French jurisdictions are much smaller geographic units. In a simple application of our method, we simulate the impact of redefining French city boundaries along pre-existing administrative lines and find strong welfare gains.

Our paper is related to the vast literature on fiscal decentralization. In his seminal paper, Tiebout (1956) argues that decentralized public good provision is efficient because people "vote with their feet" to choose their optimal bundle of taxes and public goods. However, Bewley (1981) provides a formal treatment of Tiebout's ideas and concludes that this efficiency result only holds when assuming away interesting features such as spatial spillovers and fiscal externalities. Following Oates (1972), a rich theoretical literature investigates the consequences of spillovers on local public good provision and efficient federalism (see for instance Gordon (1983), Wellisch (1994), Lockwood (2002), Besley and Coate (2003), Bloch and Zenginobuz (2007), Cheikbossian (2008), Bloch and Zenginobuz (2015)).

Some empirical work tests the presence of spatial spillovers. Solé-Ollé (2006) investigates benefits spillovers – when households enjoy public goods of neighboring cities – and congestion spillovers – when households congest such public goods – in the case of local public spending in Spain. The author finds significant evidence of both in equal magnitude. Case et al. (1993) offer a test when local public goods of neighboring cities are complements and conclude to the existence of spillovers.

On the methodological side, our paper relates to the canonical spatial equilibrium framework of Rosen (1974) and Roback (1982). Drawing on the seminal logit choice setup of McFadden (1973), this workhorse model has since been extended to account for heterogeneous mobility frictions both for households and firms (Fajgelbaum et al. (2015), Suárez Serrato and Zidar (2016)). We also relate to the large literature studying Tiebout type models with endogenous public good provision (Konishi (1996), Epple and Sieg (1999), Brueckner (2000), Bloch and Zenginobuz (2006)). Our work is also related to recent research in urban economics modelling endogenous amenities such as Ahlfeldt et al. (2015), Diamond (2016) or Fajgelbaum and Gaubert (2018). In our setup, amenities take the form of public goods and taxes that are endogenous both because of household mobility and the local voting process.

Related empirical work has investigated Tiebout type drivers of migration decisions. Early work such as Oates (1969) studies the impact of local fiscal amenities on house price capitalization. His estimates show that property values are positively affected by public spending on schools and negatively affected by local taxes. Banzhaf and Walsh (2008) look at the impact of a particular residential amenity, air quality, on city density using large plants openings. The authors find that location choices are environmentally motivated. Lutz (2015) estimates significant effects of lower property taxation on residential investment and house prices, with magnitudes depending on the elasticity of housing supply.

The rest of the paper proceeds as follows. Section 2 provides background on French local public finance and presents some empirical regularities. In section 3, we develop our spatial equilibrium model of cities with endogenous fiscal amenities. Section 4 describes our data and presents reduced-form evidence on the impact of local public good supply shocks on different economic outcomes. In section 5, we use these shocks to structurally estimate our model with GMM. Section 6 presents welfare implications. Section 7 concludes.

2 Institutional Background

In this section we provide some background on the French local institutional context. We give some historical elements on the early acknowledgement of cross-border public good spillovers and gains from coordination. We then present stylized facts to highlight the prevalence of cities in the provision of local public services and lay the foundation for our empirical analysis by discussing cities' finances.

The French local institutions belong to a four-tier system. As of 2017, the territory is divided into 35,352 cities (*communes*), nested in 1,266 municipal federations henceforth MF (*intercommunalités*), 100 counties (*départements*) and 13 provinces (*régions*). Following a series of decentralization laws starting in the early 1980's, France's local authorities increasingly gained autonomy regarding local public services. The 35,352 French cities represent around 38% of EU's total[4]. The French government long acknowledged that this large number of jurisdictions may be a source of inefficiency in the provision of local public services[5]. Because of potential economies of scale, expected reduced tax competition and better public service coordination, central authorities have created financial incentives encouraging cities to merge into larger jurisdictions[6]. Local officials however, supported by their constituents, have traditionally opposed such mergers. As a result, the number of cities have been fairly stable over time. There were around 38,000 cities in the late 18^{th} century, compared to roughly 35,000 in 2017. To bypass political obstacles to mergers, central authorities introduced the possibility for neighbouring cities to group into municipal federations. This new tier of local government, made up of elected officials from member jurisdictions, would allow cities to coordinate without loosing autonomy. Initially optional, being part of a municipal federation became compulsory in 2013. As a result, the share of federated cities jumped from 74% in 2002 to 100% in 2016, with an average of 27 member cities per federation. However, local cooperation beyond basic services remains limited and cities still control the lion's share of local public services.

French cities remain by far the largest provider of local public services as measured in € spending. In 2015, the local public sector – cities, counties and provinces – spent €229 billion or 9.4% of GDP. Cities accounted for 41 % of the total, followed by counties (35%), municipal federations (14%) and

[4]See data on local administrative areas by Eurostat *https://ec.europa.eu/eurostat/fr/web/nuts/local-administrative-units*.

[5]See report by the French Senate *https://www.senat.fr/rap/r05-193/r05-1931.html*.

[6]See Leprince and Guengant (2002).

provinces (11%). When looking at local infrastructure investments alone totalling €47 billion in 2015, the relative weight of cities is even greater. City investments represented 41% of the total, twice as much as counties (21%), provinces (20%) or municipal federations (18%). The composition of city spending further justifies the focus of the present paper as French cities are the providers of amenities that have been extensively studied in the Tiebout and urban literature. In 2009, spending on urban planning, transport and environmental policies together represented 19% of the budget, kindergarten and primary schools 13%, spending on youth and sports 10% and cultural projects 7%.

To finance local public services, cities have the autonomy to levy taxes[7]. In 2015, they raised around €50 billion or 2% of GDP in direct and indirect taxes of which 33% were from the tax on resident households, 28% from the tax on property owners, 20% from the local business tax, 2% from the land tax and the remaining 17% from various small taxes (house transaction taxes, waste management tax etc.)[8]. As an alternative source of funding, cities receive €17 billion in operating subsidies to cover operating (i.e. non-investment) expenditure. These subsidies are formula-based – loosely speaking increasing with population and decreasing with mean income – and mostly coming from the central government. Finally, cities receive around €13 billion from other smaller sources such as various user fees. Together, these sources of funding cover 116% of cities' annual operating expenses (around €69 billion in 2015), the 16% surplus being invested in infrastructure.

In 2015, French cities invested €19 billion in local infrastructure. Funding in the form of general endowments and investment-targeted subsidies accounted for 42% of total investment, the remaining 58% being financed by operating surpluses and additional debt. General endowments can take the form of in-kind gifts from the central government, or non-targeted and automatic transfers such as VAT refunds on infrastructure expenditure. Investment-targeted subsidies however are more specific and aimed at financing well-defined investment projects. These are awarded by the boards of counties, provinces and by the central government to cities that were successful in their grant application. While we do not observe city applications to investment grants, we will argue that these subsidies are a plausibly exogenous shock in local public good supply.

There is substantial cross-sectional variation in investment subsidies received each year. For the purpose of our paper we define a city's *subsidy stock* in year t as the sum of subsidies ever received by the city up to t. This *subsidy stock* concept captures how much of a city's durable public goods is being

[7]This autonomy, however, is constrained by the presence of several rules limiting year-on-year variations in tax rates.

[8]Source: Finance Ministry.

financed by public funds coming from a higher layer of government[9]. To make yearly subsidies more comparable between cities, we operate some normalization. We divide each subsidy amount received in year t by the subsidy stock at year $t-1$. The normalized yearly subsidy can then be interpreted as the growth in the city's subsidy stock.

Then, we subtract to each city-level observation the national or own MF average. In Figure 1 we report the resulting distributions pooling subsidy stocks' yearly growth in 2007, 2009 and 2010[10]. Panel A shows the pooled distribution of this percentage change in excess of the national percentage change. It exhibits substantial variation with the 1^{st} percentile being at -11% and the 99^{th} percentile at $+59\%$. Panel B shows a slightly modified distribution, where each city subsidy percentage change is taken relative to the mean change in the city's MF. Again, it exhibits substantial dispersion with the 1^{st} percentile being at -19% and the 99^{th} percentile at $+51\%$.

3 Theoretical Model

This section develops our spatial equilibrium model. It extends the seminal framework of Rosen (1974) and Roback (1982) to account for heterogeneous preferences for cities in the spirit of the recent urban economics literature. Most importantly, we allow for endogenous rents, wages, local public goods and taxes. A distinguishing feature of our model is its focus on local public goods. Endogenous fiscal amenities – taxes and public spending – are central in households' location decisions and are determined through an elementary voting mechanism.

The model shares some methodological features with the urban or economic geography frameworks of Busso et al. (2013), Ahlfeldt et al. (2015), Suárez Serrato and Zidar (2016), Diamond (2016) and Fajgelbaum and Gaubert (2018). There is a finite collection of J jurisdictions – that we will interchangeably call cities – indexed by j with fixed boundaries, as well as a finite collection of A mutually exclusive geographic areas indexed by a in which the J jurisdictions are nested. Because these nesting areas can be made arbitrarily large, our framework is flexible enough to accommodate many institutional settings. We note a_j the area j belongs to.

There is a continuum of imperfectly mobile households of measure 1, N_j being the share of households living in city j. Households inelastically supply one unit of labor in their city of residence. City

[9]Subsidies financing durable investments are recorded as a liability stock in the municipal accounts. They are depreciated at the same speed as the investment they help financing to keep reflecting their current contribution to local assets.

[10]Our data are from the French municipal financial accounts (*balance comptable des communes*) that we present in more details in section 4

j is characterized by a vector of endogenous observables – wage w_j, rental price r_j, local public good $\mathbf{G}_j$, ad valorem housing tax τ_j^h and business tax τ_j^k – as well as unobserved residential amenities. Local public goods are financed by local taxes as well as subsidies coming from the central government. A national proportional income tax τ^w finances central funding to the J jurisdictions. The sections below describe how demand for cities, housing supply, wages and local public goods are endogenously set in equilibrium.

3.1 Preferences

In order to easily connect theory and empirical analysis, we develop our conceptual framework in a Cobb-Douglas environment. Utility of household i living in city j is given by

$$U(\mathbf{C}, \mathbf{G}, i, j) = \mathbf{C}^{1-\phi}\mathbf{G}^{\phi}\mathcal{E}_j^A e^{\mu_{ij}} \tag{1}$$

where $\mathbf{C}$, $\mathbf{G}$, $\mathcal{E}_j^A$ and μ_{ij} are detailed below.

Consumption Agents enjoy aggregate consumption $\mathbf{C}$ defined by

$$\mathbf{C} = c^{1-\alpha}h^{\alpha} \tag{2}$$

where c is consumption of the nationally traded good taken as the numéraire and h is m^2 housing consumption. Parameter $\alpha \in [0, 1]$ is the housing consumption share which we assume to be constant across households. Given post-tax rental prices $r(1 + \tau^h)$ and net income $(1 - \tau^w)w$, consumption of the numéraire good is

$$c = (1 - \tau^w)w - r(1 + \tau^h)h \tag{3}$$

Public good Agents derive utility from $\mathbf{G}$, an aggregate public good measure. It takes as arguments the congested public good of the city they live in and that of all other cities belonging to the same area a due to the presence of cross-boundary spillovers. $\mathbf{G}$ will be endogenously determined along with local taxes. Parameter $\phi \in [0, 1]$ captures the taste for public good relative to private consumption. We assume that ϕ is homogeneous across households[11]. For a city j, public goods of cities belonging to a_j enter $\mathbf{G}_j$ with equal spillover weights while spillovers coming from cities outside of a_j are zero. This binary structure for spillovers' spatial decay is simplistic yet allows to flexibly test for their presence in

[11]We hence depart from the Tiebout framework with people sorting according to their taste for public good.

different settings. Aggregate public good $\mathbf{G}_j$ in j is defined as a geometric average between own and neighbours' congested public goods

$$\mathbf{G}_j = \mathbb{G}_j^{\delta} \prod_{j' \in a_j} \mathbb{G}_{j'}^{(1-\delta)/|a_j|} \tag{4}$$

where a_j is the geographic area j belongs to and $|a_j|$ its cardinal i.e the number of member cities. Parameter $\delta \in [0, 1]$ controls the intensity of spillovers that is, the extent to which households benefit from local public goods of neighbouring jurisdictions. When $\delta = 1$ there are no spillovers and residents only enjoy the public services provided in their city. When $\delta = 0$ there are full spillovers within any area a so that the city of residence does not matter for the enjoyment of public goods found in cities of a, conditional on living in a. We adopt a symmetric approach for modelling congestion. We model $\mathbb{G}_j$, the congested public good of city j, as

$$\mathbb{G}_j = \frac{G_j}{\left(N_j^{\delta} \prod_{j' \in a_j} N_{j'}^{(1-\delta)/|a_j|}\right)^{\kappa}} \tag{5}$$

with G_j a local public good index which we detail later on. Parameter $\kappa \in [0, 1]$ controls the intensity of congestion. When $\kappa = 1$, public good is fully rival and public good benefits are appropriately measured by per capita spending. When $\kappa = 0$, public good is fully non-rival and public good benefits are appropriately measured by absolute public spending. As such, κ is a parameter central to fiscal externalities. The spillover parameter δ is also involved in determining the amount of congestion deteriorating the benefits from G_j. It controls how much of public service congestion is coming from neighbouring cities as a direct consequence of symmetric benefit spillovers. Absent spillovers, $\delta = 1$ and public good in j is only congested by residents of j. When $\delta = 0$, public good in j is equally enjoyed and congested by all residents of a_j.

Residential amenities City j is further characterized by unobserved residential amenities $\mathcal{E}_j^A$. They capture the mean appeal of the city's fixed characteristics across individuals and include traditional amenities such as weather, geographic location, etc. They also capture time-varying amenities other than those explicitly modeled. These amenities are equally valued by all residents of j.

Idiosyncratic taste shocks Each individual i draws a vector $(\mu_{i1}, ..., \mu_{iJ})$ of idiosyncratic shocks. These μ_{ij}'s are assumed to be i.i.d across and among individuals and distributed Extreme Value Type-I with parameters $(0, \sigma)$. They represent individual-city specific utility premia and notably capture heterogeneity in mobility costs and in the valuation of cities' fixed amenities[12]. Parameter σ controls the dispersion of these idiosyncratic draws and is inversely related to household mobility. When σ is higher, density around the indifference threshold between any two cities is thinner as more households are infra-marginal. As a consequence, the migration response to a marginal change in the appeal of one city relative to the other gets smaller.

Model parameters to be estimated so far are $\{\sigma, \phi, \kappa, \delta\}$ respectively capturing inverse household mobility, taste for the public good, public good congestion and cross-boundary spillovers. The housing consumption share α will be calibrated from the literature.

3.2 Conditional Housing Demand

Conditional on living in j, agent i decides how much housing to consume while being net wage, rental price and tax taker. Given the constant share assumption, conditional individual housing demand and numéraire consumption equal

$$\begin{aligned} h_j^D &= \alpha \frac{(1-\tau^w) w_j}{r_j (1+\tau_j^h)} \\ c_j &= (1-\alpha)(1-\tau^w) w_j \end{aligned} \tag{6}$$

and do not depend on i. Per capita housing and numéraire consumption will hence be treated as endogenous city amenities.

3.3 Demand for Cities

Agent i chooses to live in the city that maximizes $U(\mathbf{C}, \mathbf{G}, i, j)$. We can write

$$\ln U(\mathbf{C}, \mathbf{G}, i, j) = v_j + \mu_{ij} \tag{7}$$

where

$$v_j = (1-\phi) \ln(\mathbf{C}_j) + \phi \ln(\mathbf{G}_j) + \ln(\mathcal{E}_j^A) \tag{8}$$

Households first solve for optimal housing and numéraire good consumption conditional on city of residence according to (6). After the realization of idiosyncratic shocks μ_{ij}, they make the extensive margin choice of where to live upon observing local consumption amenities $\mathbf{C}_j$'s, public services $\mathbf{G}_j$'s

[12] An interpretation of a higher value for μ_{ij} relative to any other $\mu_{ij'}$ is j being the city in which i was born, educated and socialized. Another interpretation is heterogeneity in preferences for local exogenous amenities (e.g. weather, natural amenities etc.).

as well as exogenous amenities $\mathcal{E}_j^A$'s. When comparing different cities, households are thus v_j takers. This conditional logit setup was first introduced by McFadden (1973) in a broader context of discrete choices. Demand for city j then equals the expected set of households for which it yields the highest utility i.e. $N_j^D = \mathbb{E}\left[\mathbb{1}_{\{u_{ij} > u_{iq} \, \forall \, q \neq j\}}\right]$. Because idiosyncratic shocks are distributed Extreme Value Type-I and enter utility separately from other components, demand for city j is equal to

$$N_j^D = \frac{\exp(v_j/\sigma)}{\sum_{j'} \exp(v_{j'}/\sigma)} \tag{9}$$

Loosely speaking, demand for city j is the ratio between how attractive the city is and the mean city appeal in the country. Note that with (9) no city is empty and the market for cities clears i.e.

$$\sum_j N_j^D = 1 \tag{10}$$

Total housing demand in city j is then the result of intensive margin consumption and extensive margin in-migration

$$H_j^D = h_j^D N_j^D \tag{11}$$

3.4 Housing Supply

We assume that a representative absentee landlord has the opportunity to put existing homes on the market or to develop new ones, rented at a price r per m^2 of housing. The marginal opportunity or development cost is increasing in the quantity of housing already on the market and decreasing in the city area T. Formally, the cost of providing housing is given by

$$C_j(H, T_j) = \left(\frac{H}{T_j}\right)^{1+\frac{1}{\eta_j}} \mathcal{E}_j^C$$

where η_j is the housing supply elasticity. Further differences in local housing supply determinants are captured by the cost shifter $\mathcal{E}_j^C$. Since it enters the housing supply cost function in a multiplicative way, it is isomorphic to a reduction in available land according to $T/\mathcal{E}^{C\,\frac{\eta}{1+\eta}}$. Profit maximization yields the inverse housing supply equation

$$\ln(r_j) = \frac{1}{\eta_j} \ln\left(\frac{H_j^S}{T_j}\right) + \ln(\mathcal{E}_j^C) \tag{12}$$

3.5 Labor Demand

Local labor markets are not the focus of this paper. However, our analysis needs to account for endogenous wages as they are potentially affected by endogenous business taxation and productivity e.g through public investments.

The national good is produced in each jurisdiction j with a constant returns to scale technology $F(K_j, N_j) = N_j f(\chi_j)$ where K_j is capital input, $\chi_j = K_j/(\theta_j^Y N_j)$ the capital to effective labor ratio and θ_j^Y is labor productivity. We assume that capital is supplied in all cities at a rental rate R that is fixed on international markets and that local business taxation is proportional to the outflow of local interests. We assume absentee capital owners. Firms equate the marginal product of each factor to its cost so that

$$f'(\chi_j) = (1 + \tau^k)R$$

and

$$\theta_j^Y [f(\chi_j) - \chi_j f'(\chi_j)] = w_j$$

The first of these conditions can be rewritten as $\chi_j = Z\big(R(1 + \tau^k)\big)$ with $Z' \leq 0$ and the second condition becomes

$$w_j = \theta_j^Y L\big((1 + \tau^k)R\big) \tag{13}$$

with $L(x) = f(Z(x)) - Z(x)x$. With this formulation, local wages are negatively affected by an increase in the local business tax. They are positively affected by productivity shocks θ_j^Y that may be endogenous to local public goods[13].

3.6 Public Good Supply

We let public good G be a Cobb-Douglas index

$$\ln G = \varphi \ln G^s + (1 - \varphi) \ln G^f \tag{14}$$

where G^s is the stock of public capital and G^f the flow of services annually consumed. We check the empirical validity of this specification in section 4. In practice, public durable investments typically includes schools, transportation infrastructure, parks improvements, sports facilities, museums, etc. Non-investment expenditure is typically composed of staff expenditure, maintenance of infrastructure, external services and subsidies to local associations. Both are directly measured as spending in terms of the numéraire good and we abstract from differences in public good provision efficiency. Residents

[13]Our empirical analysis would not be affected if we allowed for a more general production function with decreasing returns to scale (e.g. because of land use) or productivity agglomeration or spillovers effects as long as we econometricians observe the resulting wage. We would simply replace our inverse labor demand equation by a reduced form such as

$$w_j\Big(N_j, K_j, \tau_j^k, \{N_{j'}, K_{j'}\}_{j' \neq j}, \{\theta_{j'}^Y\}_{j'}, R\Big)$$

vote on the residence tax τ^h, the business tax τ^k and the amount of G^s and G^f. Because we assumed homogeneous preferences, the voting mechanism is akin to a maximization problem by a local social planner. We assume that residents are myopic and do not anticipate migration responses.

Residents commit to policy $\{G^s, G^f, \tau^h, \tau^k\}$ for current and all future periods[14]. They pay for G^f every year. Durable investments depreciate at the annual rate ρ. To maintain a constant level of infrastructure, residents hence have to pay G^s the first year and ρG^s every following year.

Cities inherit zero net wealth from the past[15]. However, they anticipate a flow of future subsidies $\{F_t\}_0^\infty$ and have access to international debt markets with fixed interest rate R. Residents' preferred policy is found by maximizing

$$(1-\alpha)\ln\left((1-\tau^w)w - r(1+\tau^h)h\right) + \alpha \ln h + \frac{\phi}{1-\phi}\delta\left(\varphi \ln G^s + (1-\varphi)\ln G^f\right) \tag{15}$$

over $\{G^s, G^f, \tau^h, \tau^k\}$ subject to city inter-temporal budget constraint

$$\zeta G^s + G^f = \tau^h r H + \tau^k R K + \frac{R}{1+R}\left[\sum_{t=0}^{\infty}\left(\frac{1}{1+R}\right)^t F_t\right] \tag{16}$$

where $\zeta = (\rho + R)/(1+R)$. Subsidies are financed by a national income tax τ^w that endogenously adjusts so that national budget is balanced every year i.e.

$$\tau^w = \frac{\sum_j F_j}{\sum_j N_j w_j} \tag{17}$$

Although we dot not solve for local policies in the comprehensive case, this framework will be useful in our welfare application in section 6.

3.7 Equilibrium

Definition 1. *Given the model's parameters $\{\sigma, \phi, \varphi, \kappa, \delta, \eta, \alpha, \zeta\}$ and national subsidies $\{F_t\}_0^\infty$ an equilibrium is defined by an allocation $\{N_j, H_j, w_j, r_j, G_j, \tau_j^h, \tau_j^k, \tau^w\}$ determined by the following system of equations: demand for cities* (2), (3), (14), (5), (8), (9)*; conditional housing demand* (6)*; housing supply* (12)*; labor demand* (13)*; local taxes and public good and national budget constraint* (17).

Because of agglomeration forces in the model, Definition 1 may not characterize a unique equilibrium. We argue in section 5 that structural parameters can be uniquely identified nonetheless.

[14] Appendix C shows that policy choices are time-consistent if the environment stays constant. When there is a shock to the environment (e.g. in local amenities or public subsidies) cities change their equilibrium policy which is again time-consistent.

[15] Appendix C shows that under no-Ponzi conditions, cities inherit exactly zero net wealth from past periods. Hence, there is no path-dependency in local public goods choices even in the presence of durable investments and a seemingly dynamic problem collapses into a static one.

3.8 Structural Residuals

We use equilibrium equations to uniquely identify changes in amenity and housing supply fundamentals as functions of structural parameters and changes in observable endogenous variables. These residual expressions will form the basis of our moment conditions used in our GMM estimation in section 5. For residential fundamentals, we distinguish between within-a relative changes – i.e. changes in city j's residual relative to mean changes in a_j – and between-a relative changes – i.e. mean residual changes taken at the a level relative to their national mean –. This method presents two advantages. First it allows to absorb the unobserved denominator of equation (9) roughly representing the mean attractiveness of cities in the country by expressing residuals in relative terms[16]. Second and given the assumption on the structure of spillovers, looking at within-a vs between-a changes helps isolating the spillover parameter δ.

We first use equations characterizing demand for cities to uniquely identify changes in unobserved residential amenities. Taking the log of the demand for cities equation (9) and plugging in city appeal equation (8), consumption equations (2) and (6), and public good definitions (14) and (5) allows us to uniquely express residential amenities $\ln(\mathcal{E}_j^A)$ as a function of endogenous observables and structural parameters

$$\begin{aligned}\ln(\mathcal{E}_j^A) = &-(1-\phi)(1-\alpha)\ln(1-\tau^w) - (1-\phi)(1-\alpha)\ln(w_j) \\ &-(1-\phi)\alpha\ln(h_j) - \phi\delta\ln(G_j) - \phi(1-\delta)\frac{1}{|a_j|}\sum_{j'\in a_j}\ln(G_{j'}) \\ &+\left(\sigma+\kappa\phi\delta^2\right)\ln(N_j) + \phi(1-\delta^2)\kappa\frac{1}{|a_j|}\sum_{j'\in a_j}\ln(N_{j'}) \\ &+\sigma\ln\sum_{j'}\exp(v_{j'}/\sigma) + \text{constant}\end{aligned} \tag{18}$$

Within-a transformed residuals Subtracting to each $\ln(\mathcal{E}_j^A)$ its within-a_j arithmetic mean allows us to absorb all right-hand-side terms common across cities of a_j as well as any time fixed effect contained in $\ln(\mathcal{E}_j^A)$. Finally, we first-difference the resulting equation to absorb potential city fixed effects contained

[16]We identify the model's parameters by looking at relative changes in observables without having to either fix the utility of one city, impose an outside option yielding fixed utility or make the first order approximation of assuming that cities are small so that the denominator of (9) is unaffected by changes in one city. See for instance the seminal work of McFadden (1973) and more recently Diamond (2016) or Fajgelbaum et al. (2015) for examples of how this technical point is dealt with.

in $\ln(\mathcal{E}_j^A)$. The final expression for these transformed residuals is

$$\begin{aligned}\Delta \ln \overline{\mathcal{E}_j^A} &= \left(\sigma + \kappa\phi\delta^2\right)\Delta \ln \overline{N_j} - (1-\alpha)(1-\phi)\Delta \ln \overline{w_j} \\ &\quad - \alpha(1-\phi)\Delta \ln \overline{h_j} - \delta\phi\Delta \ln \overline{G_j}\end{aligned} \tag{19}$$

where

$$\overline{X}_j = \frac{X_j}{\prod_{j' \in a_j} X_{j'}^{\frac{1}{|a_j|}}}$$

for any variable X and Δ is the first-difference operator between any two arbitrary periods. Transformed residuals (19) characterize the change in residential amenities of a given city j relative to the average amenity change in the a it belongs to. They difference out any time-invariant component in cities' unobserved residential amenities, because we take first-differences. They also difference out any component which is common across all jurisdictions of a same a in a given year because we divide endogenous variables by their geometric mean at the a level. Therefore, the mean of these transformed residuals across cities is necessarily equal to zero. Note that with full spillovers ($\delta = 0$), within-a relative public good changes have no effect on within-a relative migration responses as location does not matter for the enjoyment of public goods conditional on living in a. Alternatively, one can plug in the housing consumption expression from equation (6) and

$$\begin{aligned}\Delta \ln \overline{\mathcal{E}_j^A} &= \left(\sigma + \kappa\phi\delta^2\right)\Delta \ln \overline{N_j} - (1-\phi)\Delta \ln \overline{w_j} \\ &\quad + \alpha(1-\phi)\Delta \ln \overline{r_j} + \alpha(1-\phi)\Delta \ln \overline{\mathcal{T}_j} - \delta\phi\Delta \ln \overline{G_j}\end{aligned} \tag{20}$$

where $\mathcal{T} = 1 + \tau^h$.

Between-a transformed residuals Going back to equation (18), we first take its average at the a level for each a. Treating a as the new level of observation we then subtract to each new residential amenity expression the national arithmetic mean across all a's. The final expression for these transformed residuals is

$$\begin{aligned}\Delta \ln \widehat{\mathcal{E}_a^A} &= \left(\sigma + \kappa\phi\right)\Delta \ln \widehat{N_a} - (1-\alpha)(1-\phi)\Delta \ln \widehat{w_a} \\ &\quad - \alpha(1-\phi)\Delta \ln \widehat{h_a} - \phi\Delta \ln \widehat{G_a}\end{aligned} \tag{21}$$

where

$$\widehat{X_a} = \frac{\prod_{j \in a} X_j^{\frac{1}{|a|}}}{\prod_{a'} \left(\prod_{j \in a'} X_j^{\frac{1}{|a'|}} \right)^{\frac{1}{A}}}$$

for any variable X and A is the number of areas a. Transformed residuals (21) characterize the mean residential amenity change in a given a relative to the mean change of that same variable at the national level. They similarly absorb the a fixed effects and time fixed effects component of $\ln \widehat{\mathcal{E}_a^A}$. Importantly, these between-a transformed residuals do not feature parameter δ. Indeed, public good spillovers are contained within each a while equation (21) is at the a level. Alternatively, one can plug in the housing consumption expression from equation (6) and

$$\begin{aligned}\Delta \ln \widehat{\mathcal{E}_a^A} = \big(\sigma + \kappa\phi\big)\Delta \ln \widehat{N_a} - (1-\phi)\Delta \ln \widehat{w_a} \\ + \alpha(1-\phi)\Delta \ln \widehat{r_a} + \alpha(1-\phi)\Delta \ln \widehat{\mathcal{T}_a} - \phi\Delta \ln \widehat{G_a}\end{aligned} \tag{22}$$

Housing supply transformed residuals Using housing supply equation (12), we similarly express changes in normalized housing supply residuals by forcing $\eta_j = \eta$

$$\begin{aligned}\Delta \ln \overline{\mathcal{E}_j^C} &= \Delta \ln \overline{r_j} - \frac{1}{\eta}\Delta \ln \overline{H_j} \\ \Delta \ln \widehat{\mathcal{E}_a^C} &= \Delta \ln \widehat{r_a} - \frac{1}{\eta}\Delta \ln \widehat{H_a}\end{aligned} \tag{23}$$

While we will rely on underlying differences in η_j in our GMM estimation, this specification allows us to estimate an "average" housing supply elasticity.

3.9 From Residuals to Reduced-Form Evidence

Residual equations (19), (21) and (23) will be the foundation of our moment conditions in the GMM estimation. In the empirical analysis, the a's will be the municipal federations (MF) in their 2016 form introduced in section 2. Investigating whether these groupings of cities are relevant for further fiscal integration makes economic and historical sense. Indeed, as argued in section 2, cities grouped in MFs to internalize in part public goods externalities and rationalize costs.

The GMM estimation will use instruments for changes in the supply of local public goods. To be a valid instrument, a shock Z will need to verify $\mathbf{E}[\Delta \ln \overline{\mathcal{E}} \times Z] = 0$ that is be uncorrelated with changes in unobserved residential amenities or housing supply determinants. As can be seen in (19), (21) and (23), our residuals linearly depend on observables. DiD type reduced-form evidence showing that $\mathbf{E}[\Delta \ln \overline{Y} \times Z] = 0$ for all outcomes Y in pre-shock periods would make the case for Z as an instrument. Section 4 presents such evidence and argues that investment-targeted subsidies are a plausibly exogenous source of variation in public good supply. The exact definition of our instrument will differ whether we investigate within-MF or between-MF behavioral responses.

We expect a relatively higher public good supply shock to increase relative migration towards targeted cities, increase total housing consumption, bid up equilibrium rents in the housing market and consequently lower per capita housing m^2 consumption. Because of public good spillover effects within MFs, we would expect within-MF changes in public good supply to have a smaller impact than between-MF changes. Although labor markets are not the focus of this paper, we can conjecture that potential productivity increases would bid up equilibrium wages[17].

4 Reduced-Form Evidence

This section lays the foundation for the GMM estimation of our spatial equilibrium model. It presents the results of DiD models looking at the impact of changes in local public goods on changes in a range of economic outcomes – population, housing consumption, house prices and wages –. We take advantage of a unique combination of panel administrative datasets that were obtained from the French Department of Finance and Department of Housing. We first introduce the data and describe how we construct the variables present in the model. We then detail our empirical strategy and discuss our graphical reduced-form evidence.

4.1 Data

We combine a variety of administrative and publicly available datasets at the city level covering the 2000-2016 period.

Sample Our sample is the universe of mainland French municipalities that experience no boundary changes between 1999 and 2016. Not dropping municipalities experiencing boundary changes – such as municipalities merging or acquiring land from others – may lead to artificial variation in their supply of local public goods, population and economic outcomes. Fortunately, very few cities experience such changes and this manipulation leaves us with $34,835$ cities i.e. 96% of them, and an almost-complete partition of the French mainland territory.

Municipal financial accounts We use detailed municipal financial accounts (*Balance Comptable des Communes*) obtained from the French Department of Finance for every year between 2002 and 2016.

[17]Note that although it is not modeled here, a public good supply shock may come with a public labor demand shock that would increase equilibrium wages.

Financial accounts give us municipalities' detailed asset and liability position as well as the composition of their yearly budget. Although it would be of great interest to disentangle the various components of local public services, we are unable to classify the various items by their nature as the existing categories follow accounting definitions. It bears little consequence however as the endeavour of the present paper is more general and seeks to address the broad inefficiencies in the provision of local public services and not the effect of one particular type of investment.

We construct our public investment variable G^s as the sum of all public assets minus the raw value of the land and financial assets such as cash[18]. They are recorded at book value and account for investment depreciation. As mentioned in section 2, investments notably include schools, transportation infrastructure, parks improvements, sports facilities, museums, art collections, etc. They also include investment subsidies to other parties such as local clubs and associations. Importantly, G^s does not contain social housing units[19]. The flow of services annually consumed G^f is constructed as the sum of staff expenditure, maintenance spending, payments for external services and operating subsidies to third parties. We exclude interests payments as they do not correspond to consumable services.

As detailed in section 2 and formalized in section 3, public services are financed by local taxes and by various subsidies from the central government and upper layers of local government. Specifically, we construct a measure of the stock of investment-targeted subsidies S as the sum of all investment subsidies ever received by cities from counties, provinces and the central government minus all associated depreciation. As mentioned in section 2, S depreciates together with the public capital it helped financing. We will see that S proves a good basis for instrumenting our public good index G. In 2016, S represents 23% of the financing of our measure of public capital G^s. Endowments accounts for 28% while the remaining 41% are from local contributions – past (reserves) or future (debt) –.

Population and housing We use FILOCOM (*Fichier des Logements par Communes*) which is an exhaustive database on household housing stock. It gives information on each non-commercial dwelling every two year between 1995 and 2015. We know the location of each dwelling, its surface, vacancy status and whether it is a main or a secondary home. We also know the number of person who live in it and whether it is rented or owner-occupied. We use it to construct our city-level population and

[18]Taking out the raw value of the land seems natural as residents are unlikely to value it. Given that land is mostly a gift from the central government, erasing this asset as well as the corresponding liability from the balance sheet is neutral in our analysis. Cash and other liquid assets can be considered negative debt and are accounted for in our theoretical framework in the form of future taxes.

[19]Social housing units, when publicly owned, are held by ad-hoc entities and not by cities.

housing database which contains the stock of rented or owner-occupied main homes per city and the total and per capita housing m^2 surface. Population N_j from the model is all inhabitants of dwelling units for which the head of household is aged 20 to 65 in city j. Total housing consumption H_j is how much m^2 are consumed by the N_j residents, and per capita housing consumption is $h_j = H_j / N_j$.

House prices We use data on house prices instead of rents as there is no database on rents at the city level. We combine housing transactions database from the notary offices (named *BIEN* for the Parisian region and *PERVAL* for the rest of France). We construct a database on house prices per m^2 for every two years between 2000 and 2014 at the city level. We assume house transaction prices from the notary data are the net present value of unobserved rents r. Proportional changes in r thus equal proportional changes in house prices. This method bears two caveats, one methodological and the other regarding the quality of the price data. First, although tenants pay rent every year – explicitly or implicitly –, not all cities record house transactions every year. As such, we can infer the rent growth of a city only when it experiences a transaction in two consecutive periods. Second, the coverage of house transactions in the notary data is not exhaustive and there is notable under-reporting in rural areas.

Local tax data We use detailed local tax data (*Recensement des Eléments d'Imposition à la Fiscalité Directe Locale – REI*) for every year from 2002 to 2016. It features all tax bases and rates at the city level. We compute the *ad-valorem* local residence tax of the model from observed residence tax revenues Rev_h, total housing stock H and house prices p at the city level: $\tau^h = \frac{\text{Rev}_h}{Hr}$ where house prices are the net present value of rents $r = \frac{R}{1+R} \times p$.

Wages We use labor income data from IRCOM (*Impôt sur le Revenu par Commune*) dataset. It summarizes labor and social security total income at the city level from 2002 to 2016. We construct our city wage measure w as total labor income divided by number of tax units reporting positive labor income.

Socio-demographics and geographic data We use census data to get city-level information on total population and socio-demographic characteristics for years 1990, 1999, 2008 and 2013. We also use publicly provided data from the National Statistical Institute on city geography (municipal federation it belongs to, distance to center of urban area center, superficy etc.). Although our analysis does not study the public services handled by municipal federations, we use these geographical groupings for the definition of the a's. From 2000 to 2016, municipalities gradually joined MFs. In 2016, all municipalities belonged to municipal federations. We assign each municipality to its 2016 MF for the whole duration of our panel so that these geographical groupings are constant over time.

Table 1 gives elementary descriptive statistics on cities summarizing some of the above constructed variables.

4.2 The Public Good Index

The public good index G aims at capturing the comprehensive level of public services in a city by allowing both durable facilities G^{s} and annual spending G^{f} to benefit residents. To make sure that our constructed measures for G^{s} and G^{f} correctly reflect the amount of services chosen at the local level, we first check that they satisfy standard budget requirements. We can then directly calibrate the ratio $\frac{G^s}{G^f}$ to recover parameter φ. We first estimate parameter ρ by calibrating asset depreciation based on municipal financial accounts. Our central estimate is $\rho = 0.010$. Then we calibrate parameter R from interests paid as a share of the debt stock. Our central estimate is $R = 0.041$. Both estimates are robust across different calibration methods. We are then able to calibrate parameter $\zeta = \frac{\rho+R}{1+R}$ with a central estimate of $\zeta = 0.049$. Finally, we estimate the ratio $\frac{G^s}{G^f} = \frac{\varphi}{(1-\varphi)\zeta}$ with a log-log regression reproduced in Panel A of Figure 2. The Figure substantiates our Cobb-Douglas specification as the slope is close to unity and residuals quite small as indicated by the large R^2. Point estimate for the intercept is $1/0.074 \approx 13.5$ that is capital investment approximately equals 13.5 years of operating expenditures. This leads to a central estimate $\varphi = 0.378$. We can then rewrite our public good index G as

$$G = G^{\mathrm{s}} \left(\frac{1-\varphi}{\varphi} \zeta \right)^{1-\varphi} \approx 0.208 \times G^{\mathrm{s}}$$

4.3 Empirical Strategy

We instrument changes in local public goods using variation in plausibly exogenous investment-targeted subsidies documented in section 2. We use DiD models following Suárez Serrato and Zidar (2016) and Fuest et al. (2018) and look at cumulative changes in a range of economic outcomes around subsidy shocks. In line with the theoretical framework, we look at both within-MF and between-MFs variations in public goods and endogenous variables.

The construction of our instrument warrants a careful explanation. We want to instrument proportional changes in the endogenous variables in line with equation (19), (21) and (23). A good candidate instrument is the flow of future subsidies $\{F_t\}_t$ anticipated by the municipality. Unfortunately we do not observe these flows. However, we do observe current investment subsidy stocks S which capture the current size of national (and regional and county) contribution to local public goods. Following a simple ricardian equivalence argument, current subsidy stocks are isomorphic to streams of future investment subsidy flows. Hence, current changes in the subsidy stock, if exogenous, will provide an instrument for the unobserved flow of future subsidies thereby for the current level of public services G. Formally, our instrument is

$$\Delta \ln \overline{S}_{j,t,t-1} \tag{24}$$

for within-MF regressions i.e. the yearly log change in city subsidy stock minus the average log change in the city's MF,

$$\Delta \ln \widehat{S}_{a,t,t-1} \tag{25}$$

for between-MF regressions i.e. the yearly log change in the geometric mean of city subsidy stocks in a MF minus their average at the national (or regional, or county) level.

For a shock in a given year call d the distance (in years) from the shock, a negative d meaning prior to the shock. We run a separate regression for each $d \in [-4, 4]$ where the dependent variable is $\Delta \ln \overline{Y}_{d,-6}$ (or $\Delta \ln \widehat{Y}_{d,-6}$) that is outcome relative cumulative growth over the time period starting 8 years prior to the shock and ending d years from the shock. The main explanatory variable is the 1-year subsidy relative growth $\Delta \ln \overline{S}_{1,0}$ (or $\Delta \ln \widehat{S}_{1,0}$).

While we look at the 1-year difference in the instrument, we look at long differences in post-shock outcomes to account for construction delays, frictions in year-on-year responses by individuals and more generally for dynamic adjustments to the shock. Regression coefficients we obtain are interpreted as cumulative elasticities. To deal with potential serial correlation of the instrument we also control for all subsidy shocks happening before the shock year and before period d that is we control for all $\Delta \ln \overline{S}_{k,k-1}$ with $k \leq \min\{d, -1\}$ (or $\Delta \ln \widehat{S}_{k,k-1}$).

We pool shocks happening in 2007, 2009 and 2010 and keep only the $[-4, 4]$ distance windows around shock years to have a balanced panel in terms of distance to the shock[20]. We limit ourselves to these shocks for two reasons. First, we want to have sufficient temporal depth – i.e. 4 years of cumulative growth pre-shock – to inspect the pre-trends. This mechanically reduces the scope to shocks happening around the middle of our sample. Second, we do not include the 2008 subsidies since 2008 is a city council election year and we suspect (and empirically confirm) that subsidies that

[20]These distributed lag type of regressions are similar to the empirical setup of Fuest et al. (2018) and Suárez Serrato and Zidar (2016). However, contrary to us they do not restrict the sample to be balanced around event years which could typically leads to composition effect biases.

year were much more endogenous to city conditions. Formally, we run the following regressions

$$\Delta \ln \overline{Y}_{j,d,-6} = \beta_d^W \Delta \ln \overline{S}_{j,0,-1} + \sum_{k=-6}^{\min\{d,-1\}} \beta_k^W \Delta \ln \overline{S}_{j,k,k-1} + \mathcal{I}_j \cdot \gamma_d^W + u_{j,d}^W \tag{26}$$

for within-MF specifications,

$$\Delta \ln \widehat{Y}_{a,d,-6} = \beta_d^B \Delta \ln \widehat{S}_{a,0,-1} + \sum_{k=-6}^{\min\{d,-1\}} \beta_k^B \Delta \ln \widehat{S}_{a,k,k-1} + \mathcal{I}_a \cdot \gamma_d^B + u_{a,d}^B \tag{27}$$

for between-MF specifications for each $d \in [-4, 4]$. $\mathcal{I}$ is a vector of flexible dummies for 1999 baseline characteristics[21]. We include it as changes in unobserved amenities or housing supply costs of the model may be correlated with these observed characteristics. We cluster standard errors at the MF level to account for spatial correlation of the error term as well as auto-correlation since our regressions superimpose shocks happening in different years.

For both within-MF and between-MF regressions, we investigate responses from population, housing per capita, total housing, wage, rents, residence tax and the public good index. We estimate the reduced-form elasticities β_d's. They represent how the instrument affects cumulative outcome growth from -6 to d. These specifications absorb city or MF fixed effects because we take first differences. They also absorb time fixed effects because we divide each observation by its MF or national (or regional, or county) geometric mean. The identifying assumption is that the amount and timing of increases in the investment-targeted subsidy stock are as good as random. Absence of pre-trends i.e. $\beta_d = 0$ for $d < 0$ for all outcomes of our within-MF and between-MF regressions would strongly support this claim.

4.4 DiD Results

We present graphical evidence on the evolution of our different outcomes around subsidy shocks based on our within-MF and between-MF DiD models. These graphs have no immediate "treatment effect" interpretation but show how the gradient of different outcomes is affected by presumably exogenous changes in subsidy stocks. Their contribution, however, is twofold. They provide convincing evidence of absence of selection into treatment, as well as of significant behavioral responses to changes in local public services.

Within-MF behavioural responses Figure 3 shows the first stage result i.e. how the cumulative growth of our public good index evolves around a sudden investment subsidy shock. The graph

[21] Controls include normalized baseline 1999 city population and density.

reports our DiD coefficients β_d that is, the effect of the shock in $d = 0$ on public good's cumulative growth starting in $d = -6$. Visual inspection of the pre-trends confirms the exclusion restriction. Before $d = 0$, cumulative growth is flat and while it is significantly different from zero, it is not economically significant compared to the subsequent hike. After $d = 0$, growth in G becomes strongly positively correlated with the shock. A 1% change in the stock of investment-targeted subsidies leads to a 0.369% change in the public good index after five years. All changes are relative to the mean changes in the MF. This effect is significant at the 1% level. Although this reduced-form elasticity bears no interpretation in itself, it confirms the strong relevance of our instrument.

We now turn to the reduced-form effect of subsidy shocks on population. Figure 4 shows that treatment intensity is not correlated with city migration dynamics prior to $d = 0$. However, cities which received a relatively higher subsidy shock subsequently experienced relatively higher in-migration. A 1% relative increase in investment-targeted subsidies leads to a 0.026% relative increase in population after five years. This effect is significant at the 1% level. Put together with the first stage result, the reduced-form elasticity of population to public spending within a municipal federation is approximately 0.07. In other words, when city public spending grows 10pp more than (geometric) mean public spending in the MF, city population grows 0.7pp more than (geometric) mean population in the MF.

It is useful to give a concrete example illustrating the intensity of migration responses within municipal federations. Consider a municipal federation a in its final 2016 form with mean number of member cities (27 city members) all having 2009 mean population (1,000 residents), mean investment level (€9,400,000) and mean operating expenditure (€1,540,000). Let us abstract from public good depreciation for simplicity. Assume that city j of a raises its investment level and yearly expenditure by 10%, that is invests €940,000 in durable infrastructure and commits to increase yearly expenditure by €154,000. All other member cities of a decrease them by $10\%/26 = 0.384\% \approx 0\%$. Other cities in other MFs do not change their policies. Mean public good growth in a is zero so that a will experience no in-migration according to the model equations. City j experiences a 10pp growth in public services in excess of the zero mean MF growth, and will experience a 0.7pp population growth. This represents in-migration of 7 additional residents coming from out-migrationfrom other cities of a for an initial investment of €940,000 and an increase of €154,000 in yearly services.

Figure 5 shows how housing consumption per capita and wages evolve around the subsidy shock. Pre-trends are flat and not significantly different from zero in all panels. They make an even stronger case for investment subsidies as exogenous shocks to local public good supply. None of the endogenous outcomes – public goods, population, housing consumption and wages – exhibit pre-shock dynamics correlated with shock intensity. Panels A offers evidence that subsidy shocks are not correlated with increasing or decreasing pressure in local housing markets. Furthermore, we find that per capita housing consumption, which subsumes house prices and residence taxes responses, is not affected by the subsidy shocks. Panel B gives comfort that public investment shocks were not driven by favourable or unfavourable trends in local productivity. Wages seem to be unaffected by subsidy shocks. The distance window we consider might be too small to dissipate frictions in wage adjustments though[22]. Within-MF subsidy shocks hence seem to induce migration responses through changes in local public goods that do not capture significant changes in other endogenous city characteristics.

Table 2 reports alternative estimates without the different control variables. Our preferred estimates in column (3) correspond to the endpoints of Figures 3, 4 and 5. They are largely unaffected when we experiment with different specifications.

Between-MF behavioural responses We now investigate how MF-level changes in investment subsidies affect changes in MF-level economic outcomes. Figure 6 is the symmetric of Figure 3 and shows the first stage of our between-MF regressions. Public good cumulative growth is not significantly different from zero before the shock but it adjusts sharply after the shock. A 1% increase in the subsidy stock leads to a 0.416% increase in the public good index after five years. All changes are relative to mean regional changes taking the geometric average across each municipal federation as the new level of observation. This effect is significant at the 1% level.

Figure 7 shows that MFs which received higher subsidy shocks also experienced relatively higher in-migration. A 1% relative shock leads to a 0.152% relative population increase after five years. This effect is significant at the 1% level. It represents a population elasticity with respect to public goods of approximately 0.366 that is, a 10pp increase in public spending in excess of regional public spending growth is met with a subsequent 3.66pp excess population growth. This estimate is roughly five times higher than the point estimate of within-MF regressions. As outlined in our theoretical framework, a candidate mechanism to explain this discrepancy is the presence of cross-boundary spillovers. Indeed, in the polar case of full spillovers, changes in city local public goods relative to mean changes in the MF should not affect within-MF migration. However, changes between MFs would still affect migration decisions as we assume spillovers abruptly die out at the MF frontier.

[22]We also abstract from the possibility that agents commute to neighbor cities to work, which would dilute effects on wages even further.

Again it is useful to illustrate the intensity of migration responses between municipal federations. Consider the same setting as the above example, but this time assume that *all* cities of a increase their investment and yearly expenditure by 10%, that is invest €940,000 in durable infrastructure and commit to increase yearly expenditure by €154,000. All other cities in all other municipal federations decrease them by $10\%/1266 \approx 0\%$. Cities of a experience a mean 10pp growth in public services in excess of the zero mean growth, and will experience a mean 3.66pp population growth. This represents in-migration of 37 additional residents coming to each city of a from out-migration *from other federations* for an initial investment of €940,000 and an increase of €154,000 in yearly services.

Figure 8 suggests that this reduced-form elasticity differs from the micro (i.e. absent general equilibrium adjustments) migration responses to public good changes since it does not hold constant adjustments in other local amenities. Panel A shows again that subsidies were not awarded according to local trends in housing supply determinants. However, consumable housing per capita decreases in equilibrium in response to migration pressure and increasing marginal housing supply costs with a reduced-form elasticity of housing per capita with respect to public goods of -0.07. This also contrasts with our within-MF analysis. Panel B shows again that local productivity dynamics are not correlated with subsidy shocks. However, we find this time that wages are affected by local public goods. This result suggests that local public investment is also shifting labor demand upwards by boosting local productivity. This is further evidenced by Panel C. We report the cumulative elasticities of the (geometric) average number of businesses with respect to the subsidy stock. Contrasting this result with the absence of within-MF wage variation hints at the presence of production spillovers or commuting within municipal federations. In any case, these effects are fully captured by the residential wage variation and won't bias our spillover estimates as long as we separately instrument wage changes.

Overall these results are consistent with weaker public good spillovers between municipal federations than within. Table 3 reports alternative estimates where we let the fixed effect in the levels be at the national or county level i.e. where we divide each observation by the national or county geometric mean instead of the regional mean. They are largely unaffected when we experiment with different specifications. While the migration response seems to be smaller when absorbing county fixed effects instead of national or regional ones, it mirrors a weaker first stage intensity so that the reduced-form elasticities are comparable. Our preferred estimates in column (2) correspond to the endpoints of Figures 6, 7 and 8.

Housing supply and price capitalization Figure 9 and 10 report the results of our housing supply regressions and shows how total m^2 housing consumption and house prices (in €/m^2) are affected by our instruments. Panel A of Figure 9 reports estimates for housing consumption changes conditional on municipal federation. A 1% increase in the subsidy stock relative to the MF average increase is met with a 0.020% relative increase in total consumed m^2 by 20-65 residents after five years. This estimate is significant at the 1% level. Panel B shows house price capitalization estimate: a 1% increase in the subsidy stock is met with an insignificant 0.016% increase in house prices after five years.

Panel A of Figure 10 reports estimates for housing consumption changes conditional on region. A 1% increase in the subsidy stock relative to the regional average increase is met with a 0.132% relative increase in total consumed m^2 by 20-65 residents after five years. This estimate is significant at the 1% level. Panel B again shows house price capitalization estimate. This time, a 1% increase in the subsidy stock is met with an 0.239% increase in house prices after five years significant a 1%. Panel B hence offers comfort in our interpretation of subsidy shocks as instrumenting additional public good amenities that are positively valued by residents. Most importantly, significant house price capitalization in the between-MF regressions and not in the within-MF regressions is consistent with the presence of strong within-MF spillovers. It is worth noting that house price response is an order of magnitude larger than the per capita housing drop in the between-MF case. We argue that house price responses are more representative of the longer-term adjustment in rental prices facing newcomers as short- to medium-term housing per capita responses might be dampened by adjustment frictions. We will use house prices in our GMM to estimate the model's parameters.

Table 4 reports alternative estimates. Our preferred estimates in column (3) correspond to the end-points of Figure 9 and 10. They are robust to different specifications.

Overall, these reduced-form results show that households value local public goods as evidenced by migration responses and capitalization in house prices. They also highlight, in line with the theoretical framework, that the intensity of cross-boundary spillovers influences the magnitude of migration responses to local public good supply shocks.

4.5 Robustness Checks

We run a series of robustness checks investigating whether the observed migration patterns could be driven by mechanisms other than responses to changes in positively valued public goods.

A first concern is that changes in local public spending may not be valued by residents in themselves, but may be correlated with changes in housing supply determinants through $\mathcal{E}^C$. This would be the case if public good shocks were land improvements – new roads, pathways – of no intrinsic value but destined to welcome social housing units or private housing developments following changes in land use regulation. Residents would migrate towards cities experiencing positive housing supply shocks because of lower posted rents. More generally, if our subsidy shocks are correlated with shocks in the determinants of housing supply it may bias the interpretation of our estimates. As a first test to alleviate this concern, we can look back at the rents results of Figure 10. A positive housing supply shock would have a negative effect on rents. Our results show the exact opposite suggesting that people indeed value local public goods beyond any correlated shift in the housing supply curve. A second test is to look at how the dwelling vacancy rate evolves around the subsidy shock. A third test is to look directly at the presence of housing supply shocks by looking at changes in the success rate of building permit applications.

A second concern is that migration responses may entirely be driven by the inflow of public employees necessary to operate the new facilities or services financed by the subsidy shocks. Indeed, our model does not account for public employment. Public goods may be of little value in themselves, but workers may react to public labor demand shocks that would increase wages. It is not conceptually a problem as we could have modelled public good provision as taking public employees as input. The identification of the partial effect of public good supply would still be achieved provided that we separately instrument changes in local wages in the GMM procedure. We nevertheless assess the importance of this channel and show evidence that the public employment effect is marginal. We look at how the share of public employees in the population – crudely measured as public staff payroll divided by total local payroll – evolves around subsidy shocks. Combining this estimate with total population responses and the pre-shock shares of public employees, we conclude that observed behavioral responses coming from public employment only explain approximately 12% of total 20-65 population response (see derivations in appendix B).

4.6 Towards Moment Conditions

We provide further evidence on the absence of pre-trends by looking at the non-parametric relationship between treatment intensity and outcome changes before and after the subsidy shocks. We run kernel regression where the dependent variable is alternatively $\Delta \ln \overline{G}_{j,-6,-2}$, $\Delta \ln \overline{G}_{j,-2,4}$, $\Delta \ln \overline{N}_{j,-6,-2}$ and $\Delta \ln \overline{N}_{j,-2,4}$. The explanatory variables are the residuals obtained from a first-step regression of the subsidy shock $\Delta \ln \overline{S}_{j,-1,0}$ on 1999 city density and population[23]. Figure 11 presents the results.

In panel A the dependent variable is $\Delta \ln \overline{G}_{-6,-2}$, in panel C $\Delta \ln \overline{N}_{-6,-2}$. Panels A and C show again that the average relationship between treatment and outcome growth is close to zero before treatment. In addition, they offer evidence that city expected outcomes grow at the same rate as their MF geometric average *conditional on treatment intensity*. This richer mean-independence setting will be central to our GMM analysis. The identification assumption will be that outcome relative growth be zero in expectation in different cells of treatment intensity which is more demanding than it be uncorrelated with treatment as evidenced in section 4.4. Creating flexible indicators for treatment intensity will increase the precision of our estimates and let estimation be over-identified.

In panel B and D the dependent variables are $\Delta \ln \overline{G}_{j,-2,4}$ and $\Delta \ln \overline{N}_{j,-2,4}$. They offer reassurance that the average effects reported in the Figures of section 4.4 are not driven by outliers. Public good and migration responses are visible across the full distribution of subsidy shocks.

Figure 12 provides similar evidence on $\Delta \ln \widehat{G}_a$ and $\Delta \ln \widehat{N}_a$. Panels A and C show again the absence of correlation between treatment and pre-treatment normalized outcome growth. They similarly show that pre-shock expected outcome growth is not significantly different from zero conditional on treatment intensity. Panels B and D offer additional evidence that responses to the treatment are observed all along the distribution of treatment intensity. Finally, Figure 13 similarly shows that house prices $\Delta \ln \widehat{r}_a$ evolve in a similar fashion in different cells of treatment intensity in pre-shock periods and that the price response is coming from the full range of treatment values.

5 Structural Estimation

In this section we build on the reduced-form results to develop moment conditions for our GMM estimation. We present our structural estimates and compare them to the existing literature.

[23]The fitted values and confidence bands are computed from running kernel regressions of the dependent variable on these initial residuals and on 1000 additional samples of residuals. We generate synthetic residuals using the wild cluster bootstrap procedure proposed in Cameron et al. (2008). We assume that errors are correlated within clusters which we take to be counties. Each cluster randomly draws a +1/-1 coefficient with probability 0.5 and all residuals of a same cluster are multiplied by the same coefficient. These synthetic residuals are then added back to the original fitted values. We run the first-step regression again on this pseudo-sample and store the coefficient estimates. We do this 1000 times. We then generate 1000 pseudo-samples of residuals by fitting each saved model on the original data and saving the residuals. The graphs report the pivotal bootstrap confidence band and the bias-corrected fitted values.

5.1 Moment Conditions

Section 4.6 illustrated that our candidate instruments were likely to satisfy mean-independence conditions of the form

$$\mathbf{E}[\Delta \ln \overline{Y} \,|\, \Delta \ln \overline{S}] = 0$$

for all endogenous outcomes Y before shock years. Looking back at equations (19) and (21), notice that unobserved residuals are linear combinations of endogenous outcomes. As such, they are likely to satisfy mean-independence conditions

$$\mathbf{E}[\Delta \ln \overline{\mathcal{E}} \,|\, \Delta \ln \overline{S}] = 0$$

in pre-shock periods. Using a DiD type argument, we extrapolate these mean-independence conditions to post-shock periods. They are richer than the usual conditions of zero correlation between instrument and endogenous outcomes of the form $\mathbf{E}[\Delta \ln \overline{\mathcal{E}} \times \Delta \ln \overline{S}] = 0$. Indeed, with mean-independence of the unobserved fundamentals with respect to the original instrument, any function of $\Delta \ln \overline{S}$ may be used as an additional instrument (see Wooldridge (2010)).

We use this property and apply it to a discrete number of indicator functions: we partition the empirical distribution of $\Delta \ln \overline{S}$ (or $\Delta \ln \widehat{S}$) into subintervals of equal range. We define $\mathbb{I}_m^W$ (respectively $\mathbb{I}_m^B$) the indicator function equal to one if $\Delta \ln \overline{S}$ belongs to the subinterval m of $\Delta \ln \overline{S}$ (resp. $\Delta \ln \widehat{S}$) partition. Hence our moment conditions are:

$$\begin{aligned} &\mathbf{E}\left[\Delta \ln \overline{\mathcal{E}_j^A} \times \mathbb{I}_m^W\right] = 0 \quad \text{for all } m \in \{1, ..., M\} \\ &\mathbf{E}\left[\Delta \ln \overline{\mathcal{E}_j^A} \times \Delta \ln \overline{S_j}\right] = 0 \end{aligned} \tag{28}$$

using the within-MF expression of residential residuals (19) and

$$\begin{aligned} &\mathbf{E}\left[\Delta \ln \widehat{\mathcal{E}_a^A} \times \mathbb{I}_m^B\right] = 0 \quad \text{for all } m \in \{1, ..., M\} \\ &\mathbf{E}\left[\Delta \ln \widehat{\mathcal{E}_a^A} \times \Delta \ln \widehat{S_a}\right] = 0 \end{aligned} \tag{29}$$

using the between-MF expression of residential residuals (21). To make sure that the arbitrarily chosen number of subintervals does not affect our results, we try different specifications with different numbers of IV subintervals.

Our moment conditions impose that normalized investment-targeted subsidies are not correlated with changes in unobserved fundamentals. All outcome changes plugged in (28) and (29) are the

8-year relative cumulative growths between year −4 and year 4 around the 2007, 2009 and 2010 subsidy shocks. These moment conditions exploit the differentiated variation of the observed economic outcomes in different treatment cells. The identifying assumption is that the intensity of the subsidy shock is uncorrelated with city or MF changes in unobserved residential amenities, housing supply determinants or local productivity prior to the shock. Based on the DiD results of section 4.4 and their decomposition in section 4.6, we argue that variation in our raw IV and indicator variables $\{\mathbb{I}_k^m, \mathbb{I}_m^B\}$ is a plausibly exogenous source of variation in public good supply.

Let us clarify the economics behind the identification strategy. Ideally, we would interact our shocks with measures of local housing supply elasticity as in Diamond (2016). Intuitively, cities with inelastic housing supply at the high end of our public good shocks will see house prices go up without much additional in-migration. However, large subsidy receivers with a more elastic housing supply will experience larger in-migration and lower price increase. These different responses would allow us to separately identify our parameters. Unfortunately, we do not observe housing supply elasticities. However, this data limitation is immaterial as long as our treatment cells pick up variation in housing supply elasticity without picking up differential city dynamics.

Finally, we estimate an "average" housing supply elasticity using residuals equation (23)

$$\mathbf{E}\left[\Delta \ln \widehat{\mathcal{E}_a^C} \times \Delta \ln \widehat{S_a}\right] = 0 \tag{30}$$

We simultaneously estimate the model's parameters using a two-step non-linear GMM procedure. As shown in section 3.8, our transformed residuals are uniquely identified conditional on parameters and changes in endogenous variables. The identification of the model's parameters then hinges on the uniqueness of a global minimum in the GMM minimization procedure, which is achieved in practice[24].

The estimation requires a sufficient number of IV cells to pick up the underlying variation in housing supply elasticity. Indeed, it is unlikely that housing supply elasticity systematically differs between below-median and above-median cities for instance. Hence, too few cells yield imprecise estimates with much variation between specifications. We pick the lower bound number of cells to be that beyond which parameter estimation is stabilized. We report parameter estimates for specifications varying between 40 and 60 cells for each calibrated value of the housing consumption share.

We carry out the GMM estimation using our preferred specification i.e. after our IV has been flexibly residualized with respect to baseline 1999 density, population and past shocks for within-*a*

[24]Parameters are hence uniquely identified even if the model has several equilibria. See Ahlfeldt et al. (2015) for a more detailed discussion of this point.

and between-a specifications. As in section 4.6, bias-corrected point estimates and standard errors are computed from a wild cluster bootstrap procedure where we let the errors be arbitrarily correlated within counties and independent between counties.

5.2 Estimation Results

We report estimates of our structural parameters for different calibrated values of the housing consumption share α. Calibrating the consumption share allows us to improve the robustness of our estimates given the multiplicative fashion in which it interacts with other parameters. Tables 5, 6, 7 and 8 report estimates of the model's parameters for $\alpha \in \{0.25, 0.30, 0.35, 0.40\}$.

We estimate a taste parameter for public services ϕ that varies between 0.114 and 0.252 according to the calibrated housing share. For a given value of α, our estimate is robust across specifications of IV cells. Given the Cobb-Douglas specification of preferences, the interpretation is that communities spend between 11% and 25% of their total resources on public services. This estimate is typically increasing with the calibrated α. Indeed, a higher taste for public services is needed to compensate for given house price changes when the taste for housing is higher, holding constant migration and public good changes. Parameter ϕ is the only parameter that is directly comparable with estimates from the existing literature, which we report in Table 9. Our estimates fall in the range of existing estimates.

Estimates for inverse household mobility σ lie between 0.03 and 0.14. These estimates are much lower than those found for instance in Serrato and Wingender (2011) or Diamond (2016). First, notice that the size of the considered French jurisdictions is much smaller than the geographic unit of these studies, typically the MSA. Mobility between locations is then expected to be higher. Second, it is interesting to note that given modelling assumptions, parameter σ is isomorphic to any combination of parameters $\sigma - \tilde{\kappa}$ where $\tilde{\kappa}$ would capture positive agglomeration externalities from increased density beyond those transiting through increased public goods and potential changes in wages. Hence, our estimated σ is actually capturing mobility frictions net of all non-public and non-productive agglomeration effects, e.g. endogenous residential amenities such as in Diamond (2016).

We find substantial public good spillovers between cities of a same municipal federation. Estimates for δ all lie between 0 and 0.08. While they are typically decreasing with the calibrated α, the relationship is not trivial. When taste for housing increases, lower benefit spillovers are needed to explain observed house price increases i.e. location must matter for the enjoyment of public goods. However, higher congestion spillovers can also explain observed price changes, because additional congestion brought by new residents matters less than congestion caused by residents of neighboring cities. Our estimates show that the second effect prevails.

Recall that $\delta = 0$ means full spillovers within a municipal federation, while $\delta = 1$ means no spillovers. In line with our previous empirical evidence, our estimates suggest that spillovers are very strong in the examined French setting, with public services of a city's MF neighbors accounting for between 89% and 96% of total public goods benefiting its residents[25]. These large estimates may seem unsurprising since the large of number of French cities make it likely that travel distances between them are small.

Our estimates for public good congestion are the least robust to cell number specification. However, we find significant estimates for $\kappa\phi$ that are typically below estimates for ϕ. This points to local public services being not fully rival or subject to economies of scale, and to the existence of other sources of local inefficiencies due to fiscal agglomeration effects. Indeed, these estimates suggest that the cost of providing public services increases less than one for one with population, rendering denser cities more attractive from a public amenity perspective.

6 Welfare Implications

Our empirical analysis documented strong public good spillovers across city borders. The decentralized provision of public services is likely to be sub-optimally low i.e. there may be welfare gains from coordination. While the current subsidies from counties, regions and the central government may carry some pigovian flavour, it is unlikely that they fully tackle spillover inefficiency. In this section we simulate the welfare impact of an administrative reform merging all jurisdictions belonging to a same municipal federation. As mentioned in section 2, these groupings were historically introduced precisely to deal with spillovers and economies of scale. However, member cities still maintained a high degree of independence and it is a natural check to investigate whether this residual autonomy is at the root of significant dead-weight loss.

To ensure tractability of the equilibrium, we simplify the model. Motivated by the suppression of the French local business tax in 2011, we assume that local revenue only comes from the residence tax. We compare equilibrium situations pre- and post- merger. In both hypothetical situations, public subsidies are absent. While this setting does not enable us to evaluate a reform that departs from the current observed situation, it helps highlighting the magnitude of potential welfare gains.

[25]The weight put on own public services is $\delta + \frac{1}{|a|}(1 - \delta)$ where $|a|$ is the number of member cities in the MF. We take the mean number of member cities i.e. 27 for this computation.

This version of the model has a unique and tractable equilibrium given parameters $\{\alpha, \kappa, \sigma, \phi, \delta, \eta\}$ and geographic fundamentals $\{\mathcal{E}_j^A, \mathcal{E}_j^C, \theta_j^Y\}$. We back out these fundamentals from (1) equilibrium endogenous variables of the model – with subsidies – that we observe as econometricians, and (2) parameters that we have estimated or calibrated from the literature. In what follows, we assume that these same fundamentals keep defining the geography of a model in which subsidies are absent.

Prior to the reform, residents vote for public goods as in section 3.6 absent subsidies and business taxation. They choose the housing tax rate τ_j^h and the level of public good G_j that maximize v_j under the budget constraint $r_j N_j h_j \tau_j^h = G_j$. Following the merger, residents vote for a new level of public spending pooling tax bases of all former member cities. To keep welfare comparable between pre- and post-reform situations, we assume that prior jurisdiction blocks still exist for the purpose of labor and housing markets. The only change is the degree of cooperation in the provision of local public services, now decided at the a level for all former jurisdictions of a. Residents hence choose a housing tax τ_a^h and a level of public good G_a that maximizes v_j for j in a under the budget constraint $G_a = \sum_{j' \in a} r_{j'} N_{j'} h_{j'} \tau_a^h$[26]. We assume that the total amount of local public services is then allocated to all cities of a in proportion to their pre-reform share of the total quantity of public good in the municipal federation. This allocation rule allows us to center our welfare analysis on efficiency gains and neutralizes the redistributive channel that would be present with, say, an egalitarian allocation. Our analysis would also work with alternative allocation rules but the welfare channels would be more intricate.

We note X^o all equilibrium variables currently observed as a result of the model with subsidies. In the model without public subsidies, we call X^n the pre-reform equilibrium variables and X^m the post-reform equilibrium variables. Absent subsidies, local public good supply before the reform equals

$$\begin{aligned} 1 + \tau_j^n &= 1 + \frac{\phi(\delta + \frac{1-\delta}{|a_j|})}{(1-\phi)\alpha} \\ G_j^n \left[1 + \tau_j^n\right] &= \frac{\varphi^\varphi (1-\varphi)^{1-\varphi}}{\zeta^\varphi} \tau_j^n N_j^n w_j^n \alpha (1 - \tau^w) \end{aligned} \tag{31}$$

After the merger, local public good supply is

$$\begin{aligned} 1 + \tau_a^m &= 1 + \frac{\phi}{(1-\phi)\alpha} \\ G_j^m &= \frac{\varphi^\varphi (1-\varphi)^{1-\varphi}}{\zeta^\varphi} \frac{G_j^n}{\sum_{j' \in a_j} G_{j'}^n} \sum_{j' \in a_j} \frac{\tau_{j'}^m}{1 + \tau_{j'}^m} N_{j'}^m w_{j'} \alpha (1 - \tau^w) \end{aligned} \tag{32}$$

Using backed out fundamentals, we can express all endogenous variables in these two simulated

[26]The result of this optimization problem is the same for any city j in a, see Appendix D.

cases as functions of 2014 observables. We assume that social welfare is defined as [27]

$$\text{W} = \mathbb{E}\Big[\max_j \ln U(i,j)\Big] \tag{33}$$

Because idiosyncratic preferences are distributed Extreme Value Type-I, the welfare change associated with the reform equals

$$\begin{aligned} \Delta \text{W} &= \text{W}^m - \text{W}^n \\ &= \sigma \ln \left(\frac{\sum_j e^{v_j^m/\sigma}}{\sum_j e^{v_j^n/\sigma}} \right) \end{aligned} \tag{34}$$

In the model, utility is homogeneous to euros so we interpret these welfare changes as percentage changes of a money metric. All detailed equations are given in Appendix D.

In our baseline scenario, we simulate the welfare change from the reform by using $\alpha = 0.3$ for the housing consumption share and $\eta = 0.2$ for the housing supply elasticity that we force to be common across locations. These two values correspond to the literature's central estimates for France (see Table 9). For each parameter of $\{\kappa, \sigma, \phi, \delta\}$, we use its average estimation across specifications of section 5. Because this simulation is based on estimated parameters and fundamentals, we report the associated Monte-Carlo standard errors that we compute using the parameters' estimated variance-covariance structure.

In our central specification, we estimate that a reform that would fully merge cities at the existing federation level would increase welfare by 60%. This welfare gain is significant at the 1% level. Tables 10 and 11 report welfare change estimates for alternative values of η and α. They are largely robust across calibration for η. However they vary between 40% and 137% when we plug alternative housing consumption shares holding $\eta = 0.20$. This is expected as our GMM estimates for spillovers and taste for public services are increasing with the calibrated α, which makes welfare gains from a coordination reform increasing with α.

This strong result is unsurprising given our spillover estimates, but should be interpreted as an upper bound. First, it is obtained in a hypothetical context without public subsidies. Because current subsidies may already be correcting some of the externalities, we expect that the welfare gains from a reform departing from the current situation and holding subsidies constant would be smaller. We also emphasize that by abstracting from the political dead-weight loss that may arise under a more centralized regime, our analysis only investigated one side of the centralization efficiency trade-off.

[27] The choice of a utilitarian welfare criterion is akin to considering that policy choices are made behind the "veil of ignorance". Increasing welfare is then equivalent to increasing the expected utility of *ex-ante* homogeneous agents. Evaluating the proposed reform through the lens of an *ex-post* Pareto criterion will likely change its desirability.

More work is needed to finely assess how much the inability to tailor policies to local needs as well as other potential political frictions would decrease overall welfare gains.

7 Conclusion

This paper develops a simple yet flexible framework to test for potential welfare gains from centralization of public goods provision. We first build a spatial equilibrium model of cities with endogenous public goods. The binary structure for spillover spatial decay makes it easily amenable to empirical analysis. Our model shows how one can exploit differential behavioral responses to shocks in local public goods at different geographic levels to uncover the intensity of local spillovers.

We then bring new insights on spatial spillovers in the fragmented French institutional context by providing reduced-form evidence of migration and house price responses to changes in local public goods. We then estimate our model with GMM and document substantial public good spillovers, corroborating our reduced-form evidence. A city's neighbors' public goods account for 89-96% of total public goods benefiting its residents.

In a final exercise, we simulate the effect of a reform redefining city administrative boundaries in a simpler version of our model. Although we do not estimate the cost of centralization, our results suggest that increased coordination in the provision of public services may substantially improve welfare.

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Table 1: Descriptive Statistics on Cities

Variable	Mean	St. Dev.
Current spending[a]	1 517 088	23 022 598
Current spending per adult[b]	1 111	1 786
Investment stock[a]	9 383 611	98 714 400
Investment stock per adult[b]	13 481	24 130
Population[c]	1 746	14 614
Population 20-65[d]	994	4 573
Housing price per square meter[e]	1 570	978
Net income per adult[d]	10 848	3 614
Housing service per city[d]	16 247	83 086
Housing surface per adult[d]	39	6

Note: This table gives the averages and standard deviations across cities for some of section 4 constructed variables in 2009 or the closest available year.

[a] 2009 City accounts, author's calculations

[b] 2009 City accounts, 2008 Census data, author's calculations

[b] 2009 City accounts, 2009 FILOCOM, author's calculations

[d] 2009 FILOCOM, author's calculations

[c] 2008 Census data, author's calculations

[e] 2008 Notaries databases, author's calculations

Table 2: Within-MF Sensitivity Analysis

	(1)	(2)	(3)
	$\Delta \ln \overline{G}_j$	$\Delta \ln \overline{G}_j$	$\Delta \ln \overline{G}_j$
$\Delta \ln \overline{S}_j$	0.363^{***}	0.372^{***}	0.369^{***}
	(0.009)	(0.009)	(0.009)
	$\Delta \ln \overline{N}_j$	$\Delta \ln \overline{N}_j$	$\Delta \ln \overline{N}_j$
$\Delta \ln \overline{S}_j$	0.033^{***}	0.032^{***}	0.026^{***}
	(0.007)	(0.008)	(0.008)
	$\Delta \ln \overline{w}_j$	$\Delta \ln \overline{w}_j$	$\Delta \ln \overline{w}_j$
$\Delta \ln \overline{S}_j$	0.002	0.003	0.001
	(0.003)	(0.003)	(0.003)
	$\Delta \ln \overline{h}_j$	$\Delta \ln \overline{h}_j$	$\Delta \ln \overline{h}_j$
$\Delta \ln \overline{S}_j$	−0.006	−0.006	−0.007
	(0.003)	(0.004)	(0.004)
	$\Delta \ln \overline{\mathcal{T}}_j$	$\Delta \ln \overline{\mathcal{T}}_j$	$\Delta \ln \overline{\mathcal{T}}_j$
$\Delta \ln \overline{S}_j$	0.002	0.002	0.001
	(0.003)	(0.003)	(0.003)
Lag $\Delta \ln \overline{S}_j$		Yes	Yes
Baseline Controls			Yes
Observations	99,593	99,593	99,593

Note: This Table reports estimates for $\beta_{d=4}$ i.e. the effect of the shock happening in $d = 0$ on cumulative outcome growth between $d = -6$ and $d = 4$. Lag shocks include all past shocks up to $d = -1$. We flexibly control for baseline 1999 city population and density. Standard errors are clustered at the MF level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Between-MF Sensitivity Analysis

	(1)	(2)	(3)
	$\Delta \ln \widehat{G}_a$	$\Delta \ln \widehat{G}_a$	$\Delta \ln \widehat{G}_a$
$\Delta \ln \widehat{S}_a$	0.258***	0.416***	0.466***
	(0.048)	(0.055)	(0.055)
	$\Delta \ln \widehat{N}_a$	$\Delta \ln \widehat{N}_a$	$\Delta \ln \widehat{N}_a$
$\Delta \ln \widehat{S}_a$	0.094**	0.152***	0.148***
	(0.038)	(0.042)	(0.045)
	$\Delta \ln \widehat{w}_a$	$\Delta \ln \widehat{w}_a$	$\Delta \ln \widehat{w}_a$
$\Delta \ln \widehat{S}_a$	0.008	0.055***	0.050**
	(0.017)	(0.019)	(0.020)
	$\Delta \ln \widehat{h}_a$	$\Delta \ln \widehat{h}_a$	$\Delta \ln \widehat{h}_a$
$\Delta \ln \widehat{S}_a$	−0.036**	−0.031	−0.030
	(0.016)	(0.018)	(0.019)
	$\Delta \ln \widehat{\mathcal{T}}_a$	$\Delta \ln \widehat{\mathcal{T}}_a$	$\Delta \ln \widehat{\mathcal{T}}_a$
$\Delta \ln \widehat{S}_a$	−0.017	−0.019	−0.023
	(0.015)	(0.016)	(0.016)
Lag $\Delta \ln \widehat{S}_a$	Yes	Yes	Yes
Baseline Controls	Yes	Yes	Yes
Time FE X	County	Region	Nation
Observations	5,428	5,428	5,428

Note: This Table reports estimates for $\beta_{d=4}$ i.e. the effect of the shock happening in $d = 0$ on cumulative outcome growth between $d = -6$ and $d = 4$. Lag shocks include all past shocks up to $d = -1$. We flexibly control for baseline 1999 city population and density. In the model, time fixed effects in the residuals are assumed to be uniform at the national level hence the division of endogenous variables by their national geometric mean. Here, we allow for division by either national, regional of county geometric mean to account for year, year X region or year X county fixed effects in the structural residuals. Standard errors are clustered at the MF level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Housing Supply Sensitivity Analysis

	(1)	(2)	(3)
	$\Delta \ln \overline{H}_j$	$\Delta \ln \overline{H}_j$	$\Delta \ln \overline{H}_j$
$\Delta \ln \overline{S}_j$	0.027^{***}	0.026^{***}	0.020^{***}
	(0.007)	(0.007)	(0.007)
	$\Delta \ln \overline{r}_j$	$\Delta \ln \overline{r}_j$	$\Delta \ln \overline{r}_j$
$\Delta \ln \overline{S}_j$	-0.026	0.015	0.016
	(0.025)	(0.017)	(0.017)
Lag $\Delta \ln \overline{S}_j$		Yes	Yes
Baseline Controls			Yes
Observations			
Housing	99,593	99,593	99,593
Prices	99,593	99,593	99,593
	$\Delta \ln \widehat{H}_a$	$\Delta \ln \widehat{H}_a$	$\Delta \ln \widehat{H}_a$
$\Delta \ln \widehat{S}_a$	0.073^{**}	0.125^{***}	0.132^{***}
	(0.035)	(0.039)	(0.041)
	$\Delta \ln \widehat{r}_a$	$\Delta \ln \widehat{r}_a$	$\Delta \ln \widehat{r}_a$
$\Delta \ln \widehat{S}_a$	0.173^{**}	0.246^{***}	0.239^{***}
	(0.072)	(0.073)	(0.075)
Lag $\Delta \ln \widehat{S}_a$	Yes	Yes	Yes
Baseline Controls	Yes	Yes	Yes
Time FE X	County	Region	Nation
Observations	5,428	5,428	5,428

Note: This Table reports estimates for $\beta_{d=4}$ i.e. the effect of the shock happening in $d = 0$ on cumulative outcome growth between $d = -6$ and $d = 4$. Lag shocks include all past shocks up to $d = -2$. Controls include baseline 1999 city population and density. Standard errors are clustered at the MF level. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Structural parameters for $\alpha = 0.25$

# IV Cells	40	42	44	46	48	50	52	54	56	58	60
Spillovers (δ)	0.077	0.051	0.071	0.024	0.029	0.034	0.063	0.056	0.031	0.063	0.042
	0.011	0.005	0.008	0.009	0.012	0.014	0.007	0.007	0.017	0.007	0.009
PG Taste (ϕ)	0.114	0.150	0.139	0.142	0.147	0.138	0.155	0.175	0.153	0.163	0.148
	0.007	0.005	0.005	0.004	0.009	0.012	0.006	0.007	0.009	0.012	0.007
Mobility (σ)	0.113	0.103	0.142	0.069	0.065	0.079	0.125	0.124	0.080	0.118	0.099
	0.009	0.011	0.006	0.008	0.014	0.012	0.007	0.005	0.013	0.006	0.004
PG Congestion ($\kappa\phi$)	0.056	0.113	0.065	0.134	0.166	0.118	0.094	0.131	0.174	0.144	0.061
	0.013	0.021	0.012	0.012	0.022	0.027	0.017	0.010	0.024	0.016	0.038

Note: This Table reports our structural parameters estimation for $\alpha = 0.25$. Standard errors are computed from a wild cluster bootstrap procedure based on $1,000$ replications.

Table 6: Structural parameters for $\alpha = 0.30$

# IV Cells	40	42	44	46	48	50	52	54	56	58	60
Spillovers (δ)	0.073	0.037	0.053	0.016	0.028	0.031	0.056	0.041	0.015	0.052	0.035
	0.009	0.005	0.004	0.007	0.013	0.009	0.008	0.004	0.014	0.008	0.006
PG Taste (ϕ)	0.132	0.178	0.162	0.165	0.165	0.154	0.173	0.194	0.183	0.190	0.168
	0.004	0.009	0.009	0.005	0.007	0.011	0.009	0.007	0.012	0.012	0.007
Mobility (σ)	0.104	0.083	0.112	0.048	0.046	0.069	0.104	0.098	0.067	0.105	0.080
	0.007	0.013	0.006	0.008	0.013	0.009	0.009	0.007	0.016	0.010	0.006
PG Congestion ($\kappa\phi$)	0.063	0.152	0.100	0.160	0.168	0.138	0.109	0.166	0.197	0.161	0.064
	0.010	0.023	0.013	0.018	0.023	0.025	0.013	0.011	0.021	0.024	0.024

Note: This Table reports our structural parameters estimation for $\alpha = 0.30$. Standard errors are computed from a wild cluster bootstrap procedure based on $1,000$ replications.

Table 7: Structural parameters for $\alpha = 0.35$

# IV Cells	40	42	44	46	48	50	52	54	56	58	60
Spillovers (δ)	0.047	0.027	0.043	0.000	-.000	0.025	0.037	0.040	0.012	0.025	0.015
	0.008	0.005	0.005	0.008	0.007	0.006	0.006	0.010	0.007	0.006	0.010
PG Taste (ϕ)	0.155	0.188	0.179	0.200	0.196	0.177	0.194	0.211	0.193	0.219	0.188
	0.009	0.010	0.005	0.007	0.005	0.015	0.006	0.013	0.010	0.008	0.007
Mobility (σ)	0.092	0.071	0.088	0.031	0.014	0.063	0.092	0.086	0.045	0.071	0.065
	0.010	0.010	0.006	0.011	0.013	0.007	0.006	0.011	0.008	0.008	0.005
PG Congestion ($\kappa\phi$)	0.092	0.156	0.123	0.200	0.225	0.176	0.154	0.179	0.229	0.187	0.142
	0.023	0.020	0.017	0.013	0.009	0.043	0.019	0.019	0.015	0.012	0.033

Note: This Table reports our structural parameters estimation for $\alpha = 0.35$. Standard errors are computed from a wild cluster bootstrap procedure based on $1,000$ replications.

Table 8: Structural parameters for $\alpha = 0.40$

# IV Cells	40	42	44	46	48	50	52	54	56	58	60
Spillovers (δ)	0.035	0.019	0.037	0.007	-.001	0.014	0.025	0.027	0.017	0.023	0.017
	0.005	0.005	0.007	0.004	0.004	0.008	0.003	0.009	0.008	0.007	0.004
PG Taste (ϕ)	0.181	0.221	0.183	0.214	0.221	0.205	0.230	0.254	0.232	0.252	0.228
	0.009	0.008	0.009	0.006	0.006	0.021	0.009	0.010	0.012	0.012	0.007
Mobility (σ)	0.070	0.050	0.074	0.033	-.003	0.046	0.078	0.063	0.042	0.063	0.051
	0.007	0.014	0.005	0.007	0.012	0.015	0.005	0.008	0.015	0.011	0.010
PG Congestion ($\kappa\phi$)	0.126	0.217	0.140	0.230	0.252	0.156	0.193	0.226	0.262	0.171	0.163
	0.017	0.030	0.022	0.011	0.027	0.041	0.016	0.013	0.017	0.027	0.033

Note: This Table reports our structural parameters estimation for $\alpha = 0.40$. Standard errors are computed from a wild cluster bootstrap procedure based on $1,000$ replications.

Table 9: Structural Parameters Calibration and Estimation

Structural parameters	Values from literature	Estimation/calibration
α	Diamond (2016)[a] 43% for US non college workers and 46% for US college workers	from literature
	Combes et al. (2018)[e]:0.314 for homeowners and 0.352 for renters, and more precisely (see detail below)	
ϕ	Fajgelbaum et al. (2015): on US data	
	Serrato and Wingender (2011)[b]: [0.391,0.502] for US non college workers and [0.228,0.267] for US college workers	
	Fajgelbaum et al. (2015)[c] : [0.11,0.23]	
	Serrato and Wingender (2016)[d]:0.26	
	Diamond (2016)[a] : 0.03 for US non college workers, 0.32 for US college workers	
σ	Serrato and Wingender (2011)[b]: US non college workers [0.342, 0.399] and for US college workers [0.350, 0.376]	range from literature
	Diamond (2016)[a]: US non college workers 0.24 and US college workers0.47	
η	Diamond (2016)[a]: 0.21 with a standard deviation of 0.22	(1) GMM estimation
	Serrato and Wingender (2011)[b]: [0.407,0.813]	
	France Combes et al. (2018)[e]: 0.208 with most alternative estimates being between 0.15 and 0.30	
	seminal work Saiz (2010) us data	or (2) range from literature
ζ		calibration with our data
φ		calibration with our data
κ		estimation with GMM
δ		estimation with GMM

Detail of Combes et al. (2018), α:

	Paris	Lyon, Lille, Marseille	Pop > 200 000	Pop $\leq$ 200 000
homeowners	0.344	0.344	0.304	0.293
renters	0.369	0.367	0.382	0.285

[a] α: the author uses US CEX survey data.

ϕ: for unskilled workers $1.012/2.116 = \frac{\phi}{1-\phi}$, for skilled workers. This is a structural parameter for valuation by workers of all amenities compared to national good. It is not local public good specific. $0.274/4.026 = \frac{\phi}{1-\phi}$

σ We take σ as the inverse of the structural wage coefficient in the favorite specification (3) of the author. More precisely, it gives for US non college workers 1/0.4026=0.24 and US college workers 1/2.116=0.47

η: inverse housing supply elasticity of 0.21 with standard deviation of 0.22

[b] η=0.813 when using housing prices, =0.407 when using rents. Author's preferred specification is non linear.

[c] No parameters for σ assume the distribution of idiosyncratic shocks to follow a Frechet distribution

[d] from Fajgelbaum et al. (2015) literature review on structural parameters. See their Table A.17.

[e] Use Family expenditure survey for α values

Table 10: Welfare change estimation for α=0.30

η	ΔW mean	ΔW sd
0.15	60%	19%
0.20	63%	21%
0.25	66%	23%

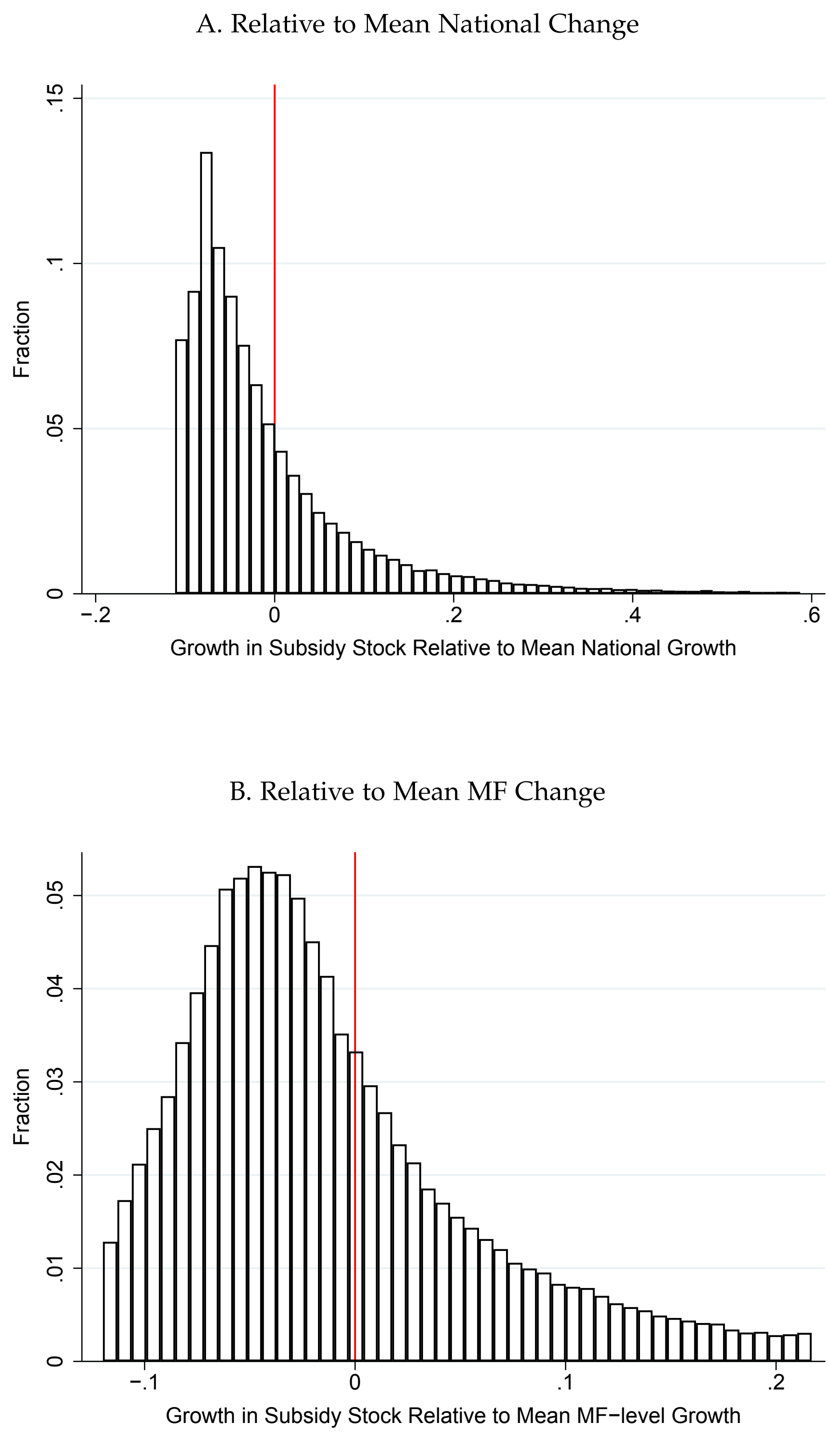
Note: This Table reports the welfare impact of a merger of all French cities at the municipal federation level in our simplified model version. Estimation for $\alpha = 0.30$. Standard errors are computed based on 1000 Monte-Carlo simulations.

Table 11: Welfare change estimation for $\eta = 0.20$

α	ΔW mean	ΔW sd
0.25	40%	13%
0.30	63%	21%
0.35	100%	29%
0.40	137%	35%

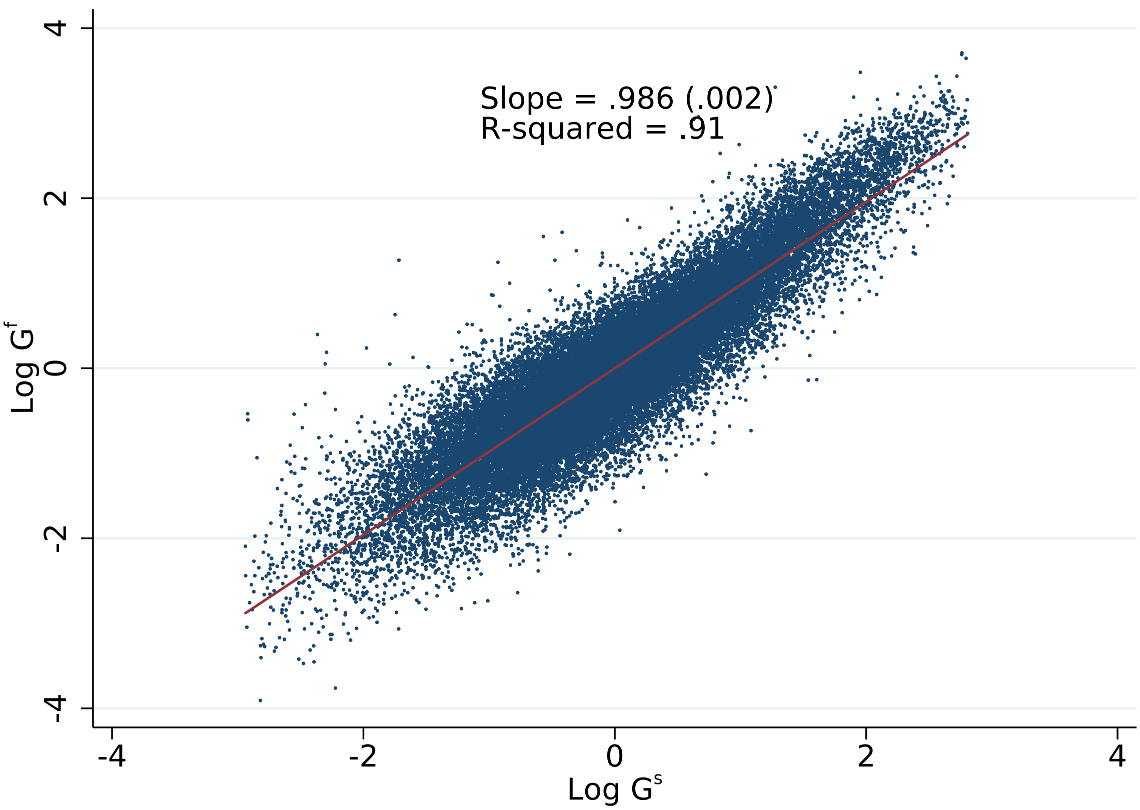
Note: This Table reports the welfare impact of a merger of all French cities at the municipal federation level in our simplified model version. Estimation for $\eta = 0.20$. Standard errors are computed based on 1000 Monte-Carlo simulations.

Figure 1: Distribution of Subsidy Stock Yearly Growth



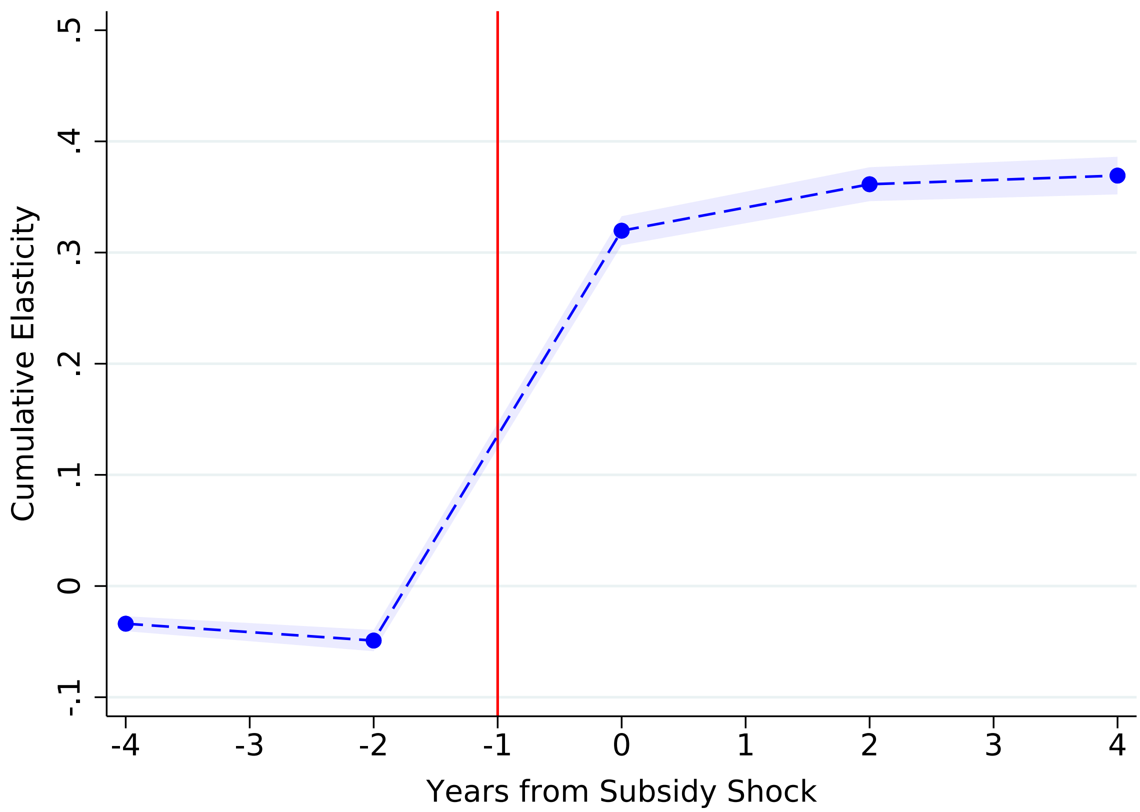
Note: These histograms plot the distribution of the yearly growth in normalized subsidy stocks pooling years 2007, 2009 and 2010. Panel A normalizes each city-level observation by the national geometric mean. Panel B normalizes each city-level observation by the geometric mean of all cities belonging to the city's MF. In each panel, top and bottom 1% observations are censored for exposition purposes.

Figure 2: Model Fit: G^f vs G^s



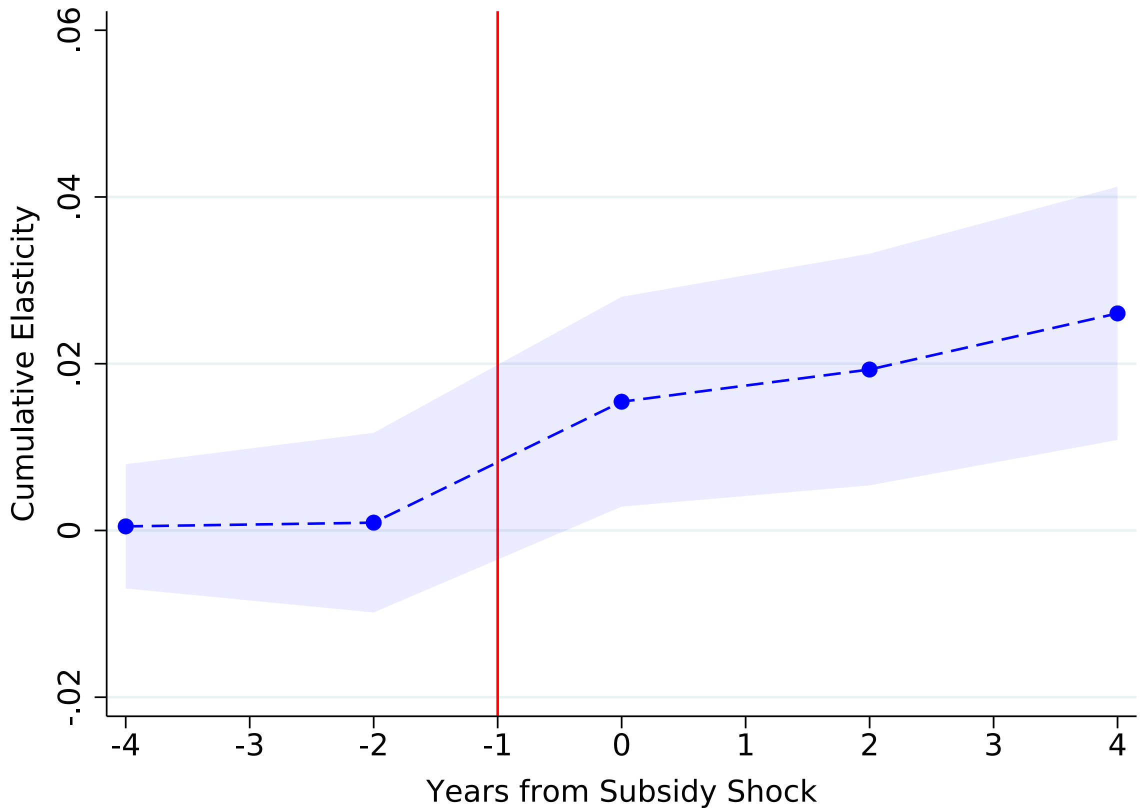
Note: This Figure shows the calibration exercise we carry out for our Cobb-Douglas modeling of how public services enter utility.

Figure 3: Within-MF Public Good Changes



Note: This graph plots the coefficients β_d of section 4 regressions. It shows the effect of changes in a city's subsidy stock in year 0 on cumulative changes in local public good starting 6 years prior to the shock year. All changes are relative to mean changes in the MF. Standard errors are clustered at the MF level. We report the 5% confidence bands.

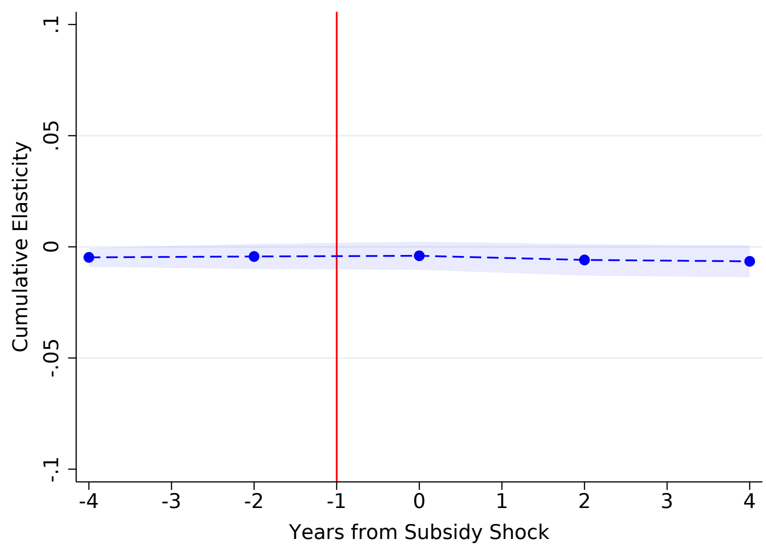
Figure 4: Within-MF Migration Response



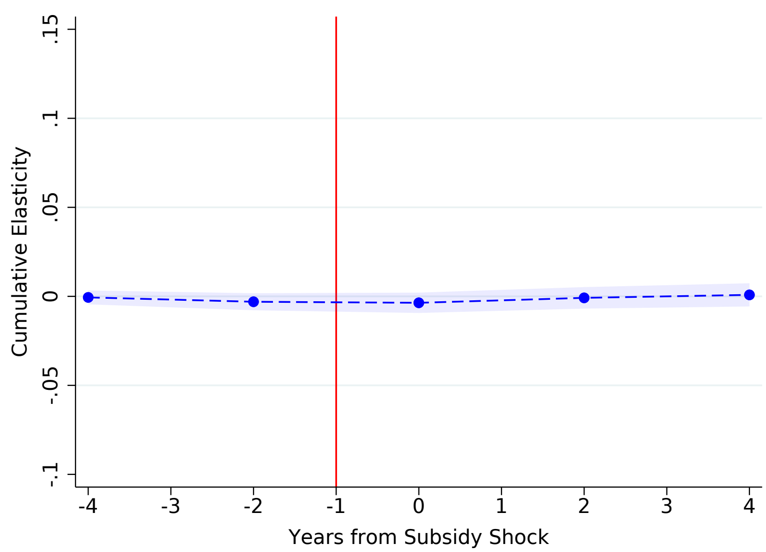
Note: This graph plots the coefficients β_d of section 4 regressions. It shows the effect of changes in a city's subsidy stock in year 0 on cumulative changes in the number of residents aged 20-65 starting 6 years prior to the shock year. All changes are relative to mean changes in the MF. Standard errors are clustered at the MF level. We report the 5% confidence bands.

Figure 5: Within-MF Per Capita Housing and Wage

A. Per Capita Housing Consumption (in m^2)

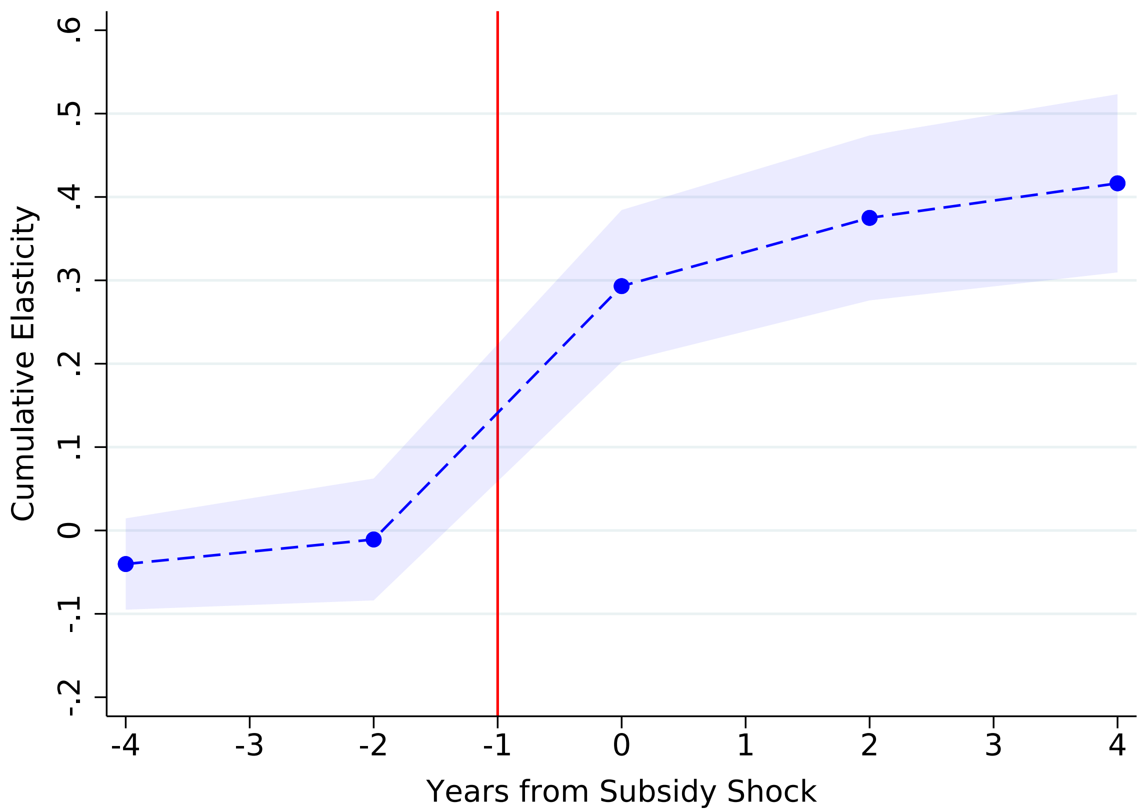


B. Wage



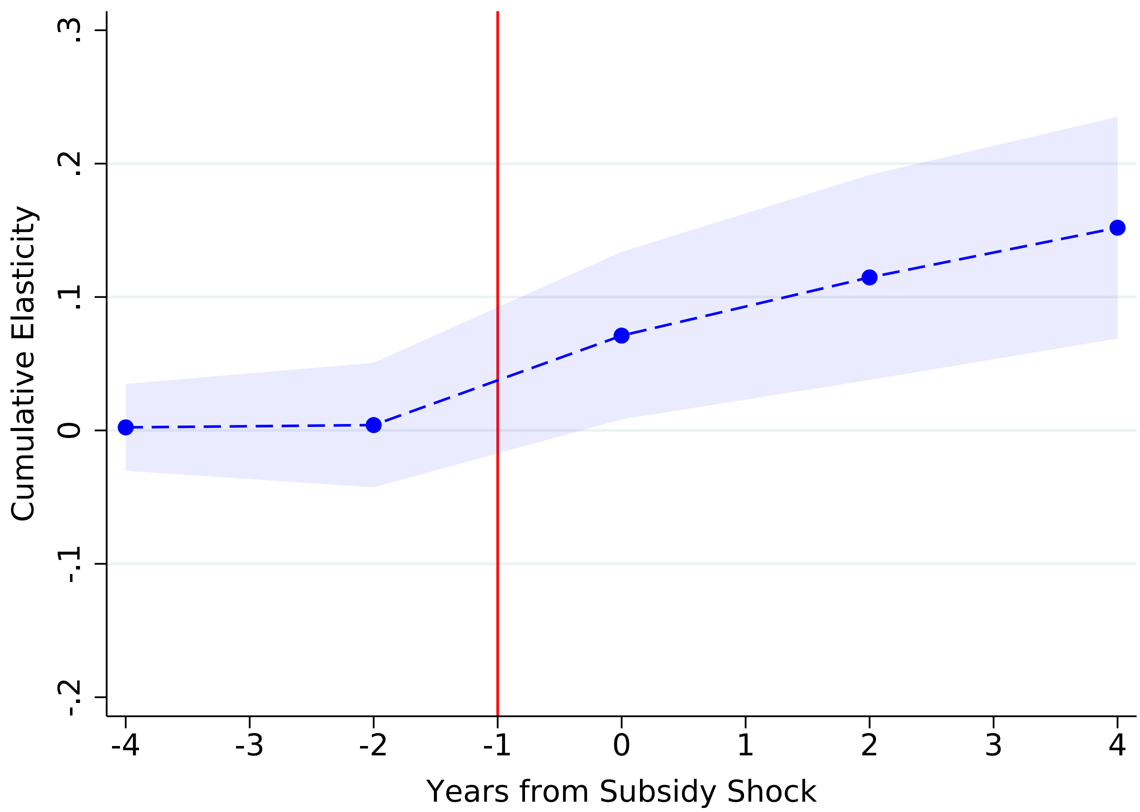
Note: These graphs plot the coefficients β_d of section 4 regressions. They show the effect of changes in a city's subsidy stock in year 0 on cumulative changes in per capita housing consumption, wages and house prices starting 6 years prior to the shock year. All changes are relative to mean changes in the MF. Standard errors are clustered at the MF level. We report the 5% confidence bands.

Figure 6: Between-MF Local Public Good Changes



Note: This graph plots the coefficients β_d of section 4 regressions. It shows the effect of changes in a MF subsidy stock in year 0 on cumulative changes in local public goods starting 6 years prior to the shock year. All changes are relative to regional mean changes. Standard errors are clustered at the MF level. We report the 5% confidence bands.

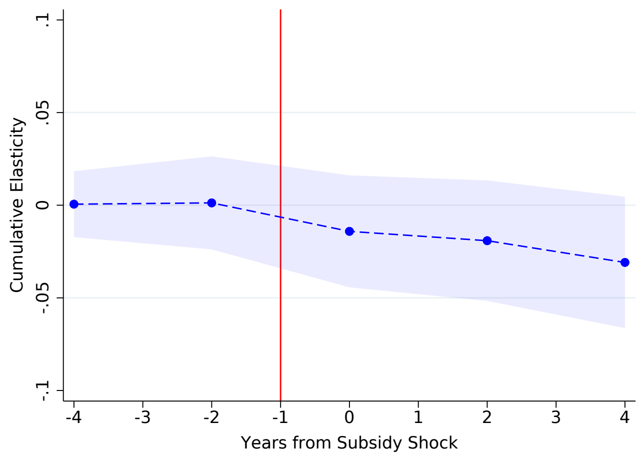
Figure 7: Between-MF Migration Response



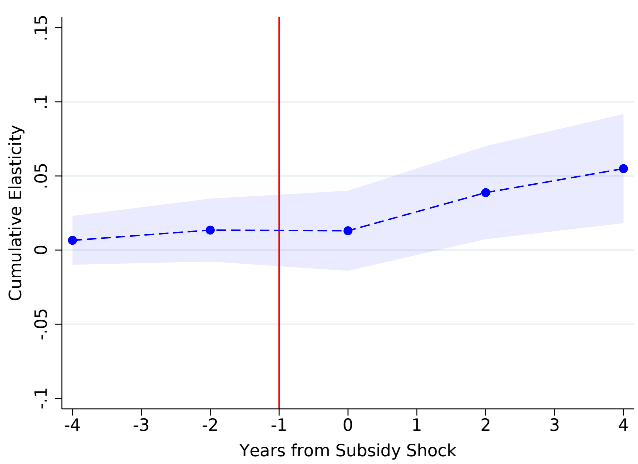
Note: This graph plots the coefficients β_d of section 4 regressions. It shows the effect of changes in a MF subsidy stock in year 0 on cumulative changes in population starting 6 years prior to the shock year. All changes are relative to regional mean changes. Standard errors are clustered at the MF level. We report the 5% confidence bands.

Figure 8: Between-MF Per Capita Housing and Wage

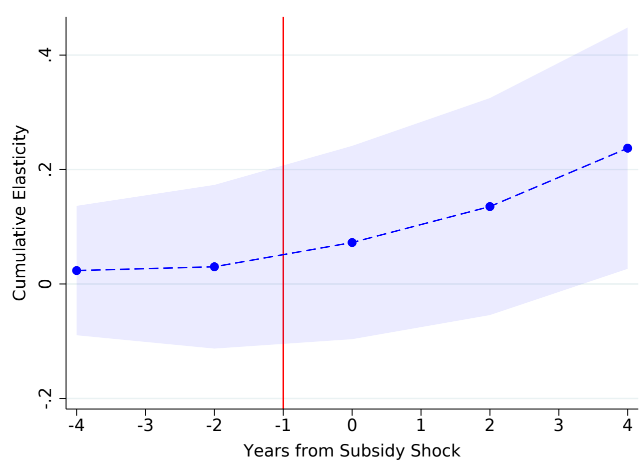
A. Per Capita Housing Consumption (in m^2)



B. Wage



C. Recorded Businesses

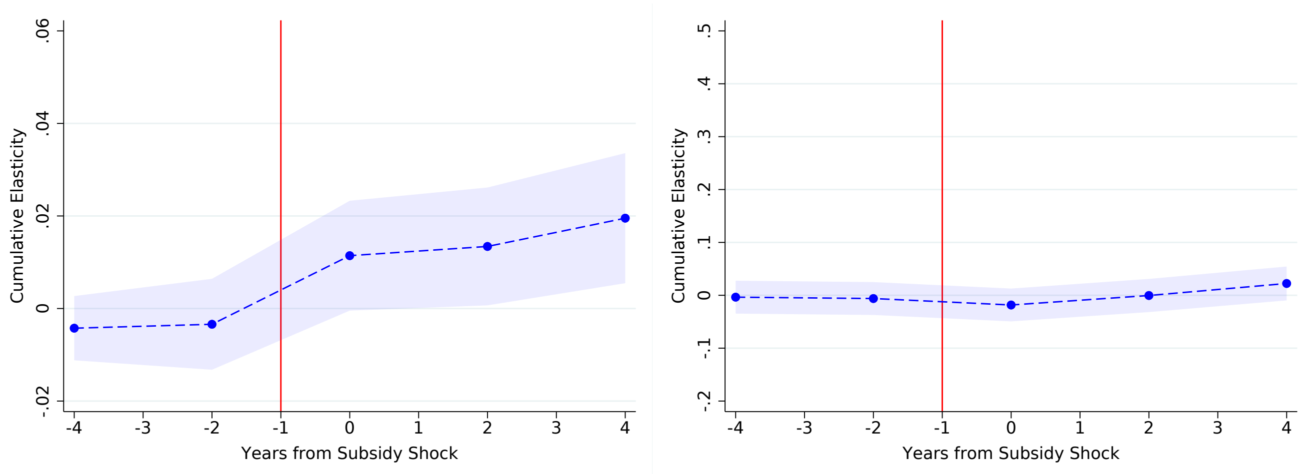


Note: These graphs plot the coefficients β_d of section 4 regressions. They show the effect of changes in a MF subsidy stock in year 0 on cumulative changes in per capita housing consumption, wages and house prices starting 6 years prior to the shock year. All changes are relative to regional mean changes. Standard errors are clustered at the MF level. We report the 5% confidence bands.

Figure 9: Within-MF Housing Supply and House Prices

A. Total Housing Consumption (in m^2)

B. House Prices

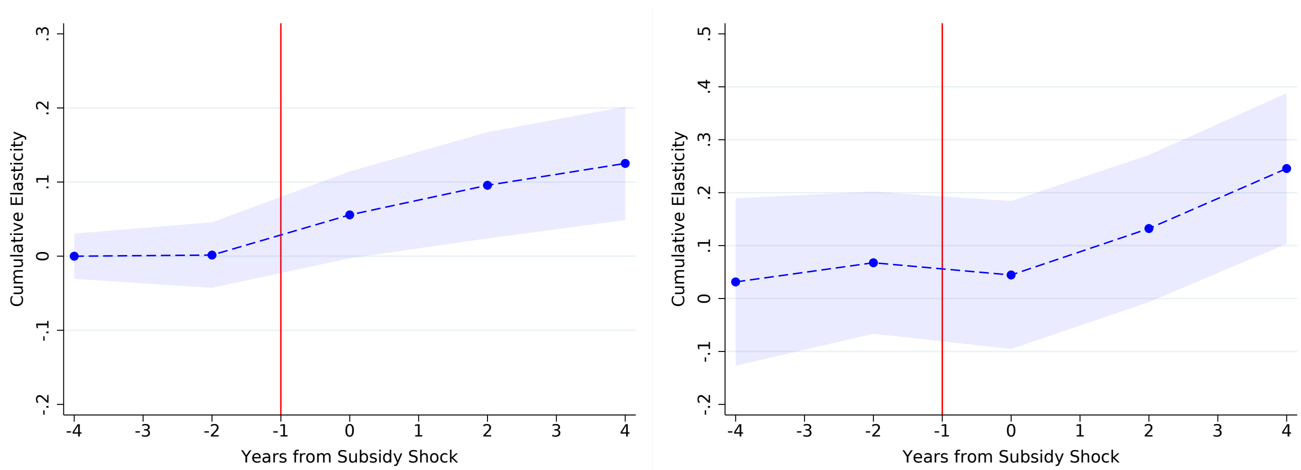


Note: These graphs plot the coefficients β_d of section 4 regressions. They show the effect of changes in a city's subsidy stock in year 0 on cumulative changes in total m^2 of housing consumed starting 6 years prior to the shock year. All changes are relative to MF mean changes. Standard errors are clustered at the MF level. We report the 5% confidence bands.

Figure 10: Between-MF Housing Supply and House Prices

A. Total Housing Consumption (in m^2)

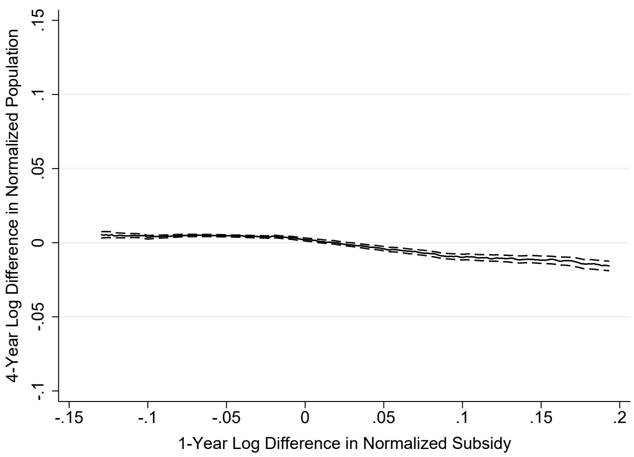
B. House Prices



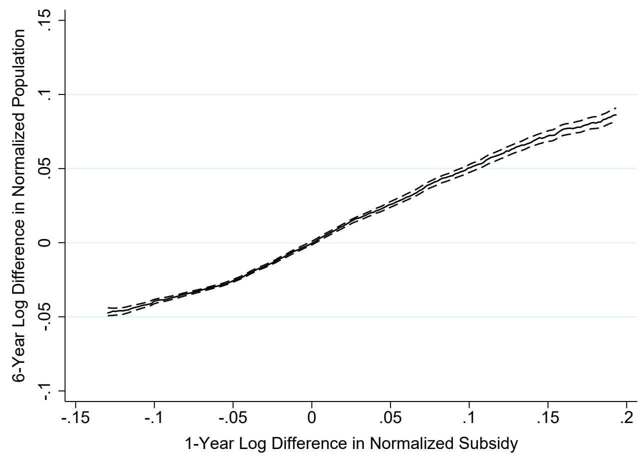
Note: These graphs plot the coefficients β_d of section 4 regressions. They show the effect of changes in a city's subsidy stock in year 0 on cumulative changes in total m^2 of housing consumed starting 6 years prior to the shock year. All changes are relative to regional mean chang. Standard errors are clustered at the MF level. We report the 5% confidence bands.

Figure 11: Kernel Regressions: Within-MF Changes

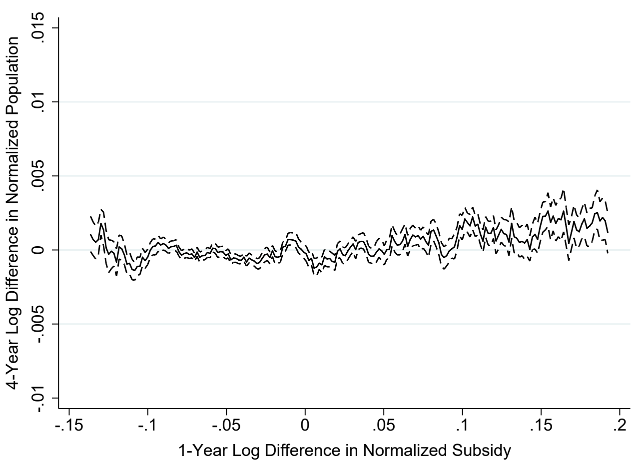
A. *G* 4-year Relative Growth Pre-Shock



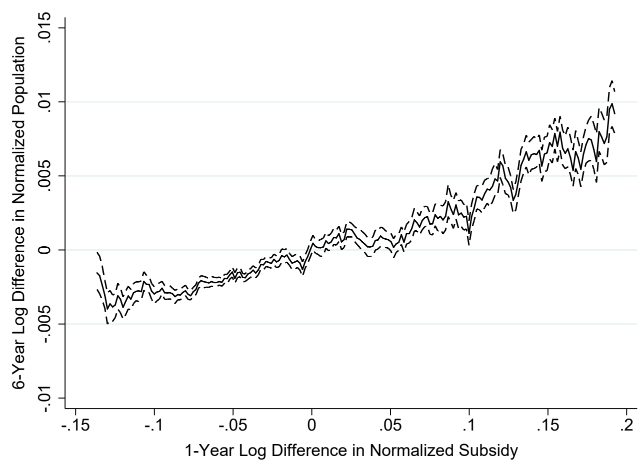
B. *G* 6-year Relative Growth Post-shock



C. *N* 4-year Relative Growth Pre-Shock

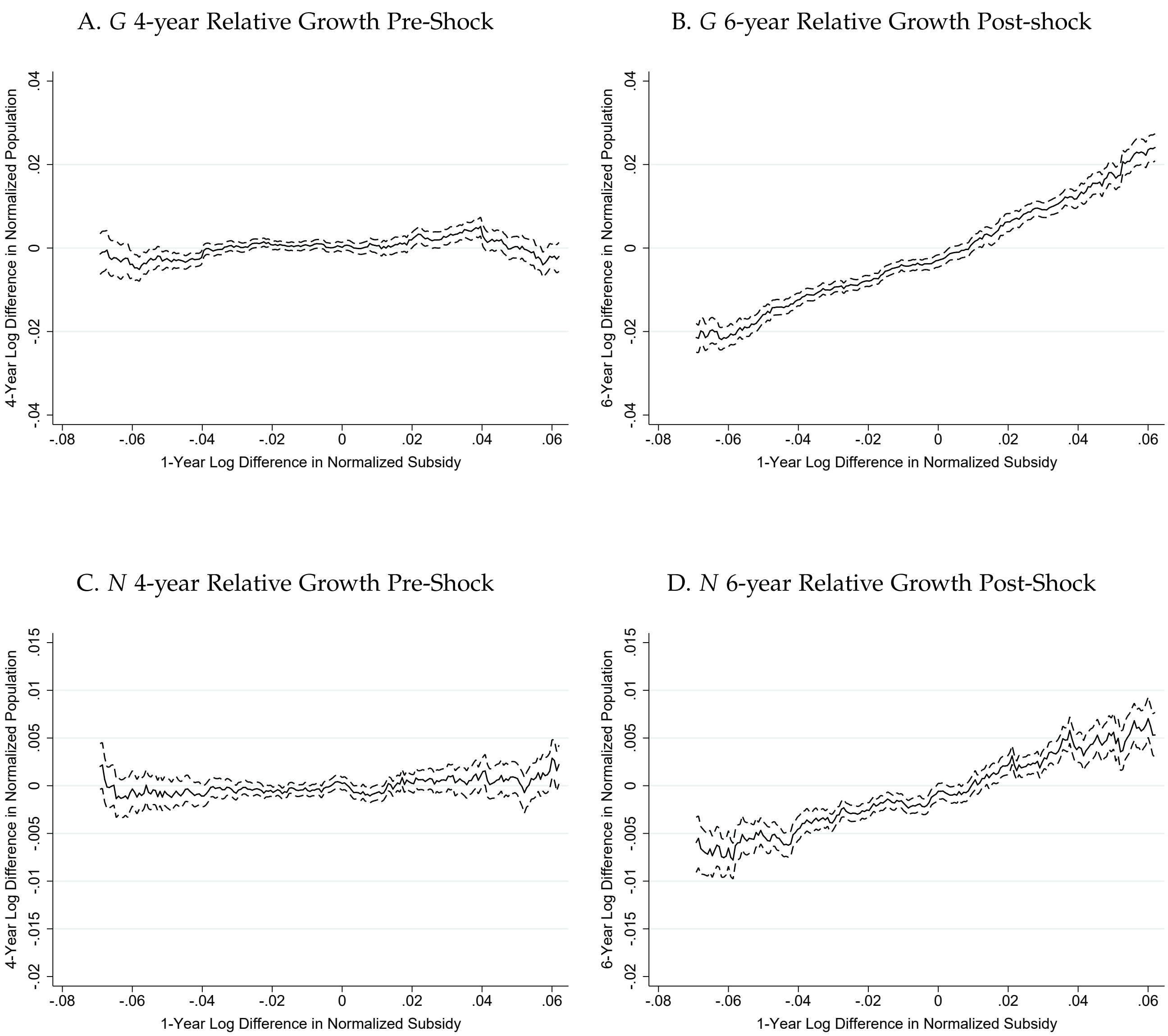


D. *N* 6-year Relative Growth Post-Shock



Note: This Figure shows the outcomes of non-parametric regressions where the explanatory variable is the within-MF relative subsidy shock. Dependent and explanatory variables are first residualized with respect to bins of fixed 1999 characteristics and lagged shocks. Bias-corrected fitted values and 1% confidence band are computed based on 1000 bootstrap replications.

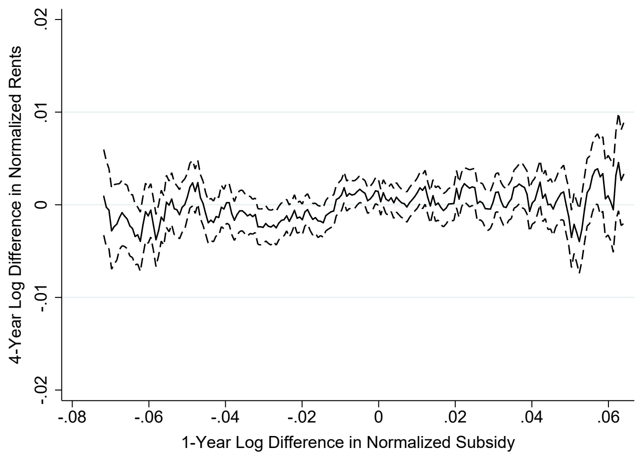
Figure 12: Kernel Regressions: Between-MF Changes (1/3)



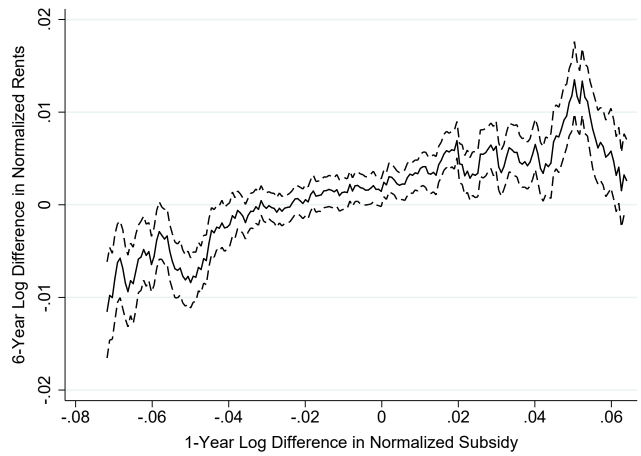
Note: This Figure shows the outcomes of non-parametric regressions where the explanatory variable is the between-MF relative subsidy shock. Dependent and explanatory variables are first residualized with respect to bins of fixed 1999 characteristics and lagged shocks. Bias-corrected fitted values and 1% confidence band are computed based on 1000 bootstrap replications.

Figure 13: Kernel Regressions: Between-MF Changes (1/3)

A. r 4-year Relative Growth Pre-Shock



B. r 6-year Relative Growth Post-Shock



Note: This Figure shows the outcomes of non-parametric regressions where the explanatory variable is the between-MF relative subsidy shock. Dependent and explanatory variables are first residualized with respect to bins of fixed 1999 characteristics and lagged shocks. Bias-corrected fitted values and 1% confidence band are computed based on 1000 bootstrap replications.

Appendices

A City Appeal

$$
\begin{aligned}
v_j = {} & (1-\phi)(1-\alpha)\ln(1-\alpha) + (1-\phi)(1-\alpha)\ln(1-\tau^w) + (1-\phi)(1-\alpha)\ln(w_j) \\
& + (1-\phi)\alpha\ln(h_j) + \phi\delta\ln(G_j) + \phi(1-\delta)\frac{1}{\#a_j}\sum_{j'\in a_j}\ln(G_{j'}) - \phi\delta^2\kappa\ln(N_j) \\
& - 2\phi\delta(1-\delta)\kappa\frac{1}{\#a_j}\sum_{j'\in a_j}\ln(N_{j'}) - \phi(1-\delta)^2\kappa\frac{1}{\#a_j}\sum_{j'\in a_j}\ln(N_{j'}) + \ln(\mathcal{E}_j^A)
\end{aligned}
\tag{35}
$$

B DiD Robustness Checks

Let city total 20-65 population be

$$N = N_{\bar{p}} + N_p$$

where N_p is the public sector population. Let $s_p = N_p/N$ be the pre-shock share of public employees in the population. Within-MF changes in N following a shock can be decomposed as follows

$$
\begin{aligned}
d\ln(N/\overline{N}) &= \frac{d(N/\overline{N})}{N/\overline{N}} \\
&= \frac{d(N_{\bar{p}}/\overline{N})}{N/\overline{N}} + \frac{d(N_p/\overline{N})}{N/\overline{N}} \\
&= \frac{d(N_{\bar{p}}/\overline{N})}{N/\overline{N}} + \frac{d(s_pN/\overline{N})}{N/\overline{N}} \\
&= \frac{d(N_{\bar{p}}/\overline{N})}{N/\overline{N}} + s_p\left[\frac{d(N/\overline{N})}{N/\overline{N}} + \frac{ds_p}{s_p}\right]
\end{aligned}
$$

The share of migration responses coming from public employment is then

$$\frac{\frac{d(N_p/\overline{N})}{N/\overline{N}}}{\frac{d(N/\overline{N})}{N/\overline{N}}} = s_p\left[1 + \frac{ds_p/s_p}{\frac{d(N/\overline{N})}{N/\overline{N}}}\right]$$

Figure 14 shows an estimate for $\frac{ds_p/s_p}{\frac{d(S/\overline{S})}{S/\overline{S}}}$ of around 0.09. The estimate for $\frac{\frac{d(N/\overline{N})}{N/\overline{N}}}{\frac{d(S/\overline{S})}{S/\overline{S}}}$ from section 4.4 is around 0.03. The average estimate for the pre-shock ratio of public staff to total 20-65 population is $s_p \approx 3\%$. Estimate for the share of migration responses coming from public employment is hence

$\approx 3\% \times (1 + 0.09/0.03) = 12\%$. We get similar estimates when when including paid subsidies to third parties in addition to public staff payroll.

C Local Public Good Supply: Time Consistency and No Inherited Wealth

We let public good G be a Cobb-Douglas index

$$\ln G = \varphi \ln G^s + (1-\varphi) \ln G^f \tag{36}$$

where G^s is the stock of public capital and G^f the flow of services annually consumed. Both are directly measured as spending in terms of the numéraire good and we abstract from differences in public good provision efficiency. Residents vote on the residence tax τ and the amount of G^s and G^f. Because we assumed homogeneous preferences, the voting mechanism is akin to a maximization problem by a local social planner. We assume that residents are myopic and do not anticipate migration responses.

Residents commit to policy $\{G^s, G^f, \tau\}$ for current and all future periods. They pay for G^f every year. Durable investments depreciate at annual rate ρ. To maintain a constant level of infrastructure, residents hence have to pay G^s the first year and ρG^s every following year. Cities inherit investment G^s_{init} and debt D_{init} from the past. In addition, they anticipate a constant flow of future subsidies equal to F. Cities have access to international debt markets with fixed interest rate R. Residents' preferred policy is given by

$$\max_{G^s, G^f, \tau} \quad (1-\alpha)(1-\phi) \ln\Big((1-\tau^w)w - r(1+\tau^h)h\Big) + \alpha(1-\phi)\ln(h) + \phi(\delta + \frac{1-\delta}{|a_j|})\Big(\varphi \ln(G^s) + (1-\varphi)\ln(G^f)\Big)$$

That is, after substituting in optimal housing and numéraire consumption

$$\max_{G^s, G^f, \tau} -\alpha(1-\phi)\ln(1+\tau) + \phi(\delta + \frac{1-\delta}{|a_j|})\Big(\varphi \ln(G^s) + (1-\varphi)\ln(G^f)\Big)$$

C.1 Optimal policy from t=0 (creation of the city)

In period $t = 0$ (e.g. the creation of the city), cities inherit zero investments $G^s_{init} = 0$ and debt $D_{init} = 0$. Residents choose and commit to a constant level of public good G_0 and a constant tax rate τ_0 for current and all future periods $\{t = 0, t = 1, ...\}$. They furthermore assume that population won't change in future periods. When population changes because of say an amenity shock, the problem is reinitialized at period 0, but this time with a history and an a priori non-zero initial city net wealth. Public goods are durable but depreciate at speed ρ. To commit to the initially chosen G^s_0 residents hence have to invest ρG_0^s every period from $t = 1$. Residents receive a flow of subsidy equal to F and is assumed constant over time (again, if F changes the problem is reinitialized at period 0 with an a priori non-zero initial net wealth). Cities can levy debt each year $\{D_0, D_1, D_2, ...\}$ that has to be repaid in full the next year, plus interests. Yearly budgets are given by

$$\begin{aligned} G_0^s + G_0^f &= D_0 + \tau_0 Nhr + F \\ \rho G_0^s + G_0^f &= -(1+R)D_0 + D_1 + \tau_0 Nhr + F \\ \rho G_0^s + G_0^f &= -(1+R)D_1 + D_2 + \tau_0 Nhr + F \\ &\vdots \\ \rho G_0^s + G_0^f &= -(1+R)D_{t-1} + D_t + \tau_0 Nhr + F \\ &\vdots \end{aligned} \tag{37}$$

Let's multiply each budget line by

$$p_t = \left(\frac{1}{1+R}\right)^t \tag{38}$$

and sum all lines up to $t = T$

$$G_0^s + \rho G_0^s \sum_{t=1}^{T} p_t + G_0^f \sum_{t=0}^{T} p_t = \sum_{t=0}^{T} p_t D_t - (1+R) \sum_{t=1}^{T} p_t D_{t-1} + \tau_0 Nhr \sum_{t=0}^{T} p_t + F \sum_{t=0}^{T} p_t \tag{39}$$

that is

$$G_0^s + G_0^f + (\rho G_0^s + G_0^f) \sum_{t=1}^{T} p_t = p_T D_T + \tau_0 Nhr \sum_{t=0}^{T} p_t + F \sum_{t=0}^{T} p_t \tag{40}$$

Take the limit when $T \to \infty$ assuming that the no-Ponzi scheme condition holds *ie* that

$$\lim_{T \to \infty} p_T D_T = 0 \tag{41}$$

We get the inter-temporal budget constraint

$$\zeta G_0^s + G_0^f = \tau_0 Nhr + F \tag{42}$$

Note that we can express the debt stock at all t by solving

$$D_t = (1+R)D_{t-1} + \rho G_0^s + G_0^f - \tau_0 Nhr - F = (1+R)D_{t-1} + (\rho - 1)G_0^s + D_0$$

i.e. (noticing an arithmetico-geometric sequence)

$$D_t = (1+R)^t \left(D_0 \frac{1+R}{R} + (\rho - 1) G_0^s \frac{1}{R} \right) - \frac{1}{R} \left((\rho - 1) G_0^s + D_0 \right)$$

rewriting

$$p_t D_t = D_0 \frac{1+R}{R} + (\rho - 1) G_0^s \frac{1}{R} - p_t \frac{1}{R} \Big((\rho - 1) G_0^s + D_0 \Big)$$

Taking the limit when $t \to \infty$ using the no-Ponzi condition yields

$$0 = D_0 \frac{1+R}{R} + (\rho - 1) G_0^s \frac{1}{R} \tag{43}$$

so that finally we show that debt is constant and that we are in a stationary setting (holding environment fixed).

$$D_t = D_0 = \frac{1-\rho}{1+R} G_0 \tag{44}$$

C.2 Optimal policy from t=1 (keeping environment fixed)

At period 1, cities inherit debt (plus interests) and depreciated assets from period 0 that is

$$(1-\rho) G_0^s - (1+R) D_0$$

However, according to equation (43) this quantity is exactly zero. The optimization problem in period 1 is hence the same as in period 0, and policy choices from period 1 onward are unchanged compared to those in period 0. The proof by induction for any t follows straightforwardly.

C.3 Optimal policy from t=1 (with a change in the environment)

Initial net city wealth is zero so the problem is reinitialized at period zero following a shock to the environment. The environment has changed however, so policy choices may be different in the new equilibrium.

D Welfare

D.1 Getting the residuals

In the simplified case where we assume away public subsidies and revenues other than the residence tax, the equilibrium is defined by the following equations.

$$N_j = \frac{\exp(v_j/\sigma)}{\sum\limits_{j'} \exp(v_j/\sigma)} \tag{45}$$

$$v_j = (1-\phi)\alpha \ln \alpha + (1-\phi)(1-\alpha)\ln(1-\alpha) \tag{46}$$

$$+ (1-\phi)\ln((1-\tau^w)w_j) - (1-\phi)\alpha \ln(1+\tau_j^h) - (1-\phi)\alpha \ln(r_j) \tag{47}$$

$$+ \phi\delta \ln(G_j) + \phi \frac{1-\delta}{\# a_j} \sum_{j \in a_j} \ln G_{j'}$$

$$- \phi\kappa\delta^2 \ln N_j - \phi\kappa \frac{1-\delta^2}{\# a_j} \sum_{j \in a_j} \ln N_{j'} + \sigma\theta_j^A$$

$$\ln(r_j) = \frac{1}{\eta} \ln \frac{H_j}{T_j} + \theta_j^C \tag{48}$$

$$1 + \tau_j^h = 1 + \frac{\phi(\delta + \frac{1-\delta}{|a_j|})}{(1-\phi)\alpha} \tag{49}$$

$$G_j\left[1+\tau_j^h\right] = \frac{\varphi^\varphi (1-\varphi)^{1-\varphi}}{\zeta^\varphi} \tau_j^h N_j w_j \alpha (1-\tau^w) \tag{50}$$

Equations 49 and 50 are the vote conditions in our simplified version [28]. Equations 45, 47 and 48 are identical in the simplified case and in our baseline model with subsidies.

We note $N^o, G^o, v^o, r^o, \tau^o$ all the equilibrium variables in the normal case and $N^n, G^n, v^n, r^n, \tau^n$ all equilibrium variables in the simplified version. With our data we observe each year a set of equilibrium variables $N^o, G^o, v^o, r^o, \tau^o$. We show that we can deduce equilibrium variables $N^n, G^n, v^n, r^n, \tau^n$ from observed data. It is equivalent to infer residuals θ_j^A, θ_j^C from observed data.

We rewrite equilibrium conditions 45, 47 and 48

$$N_j = \frac{\exp(v_j/\sigma)}{\sum\limits_{j'} \exp(v_{j'}/\sigma)} \tag{51}$$

$$v_j = -\frac{\eta}{\eta+1}(1-\phi)\alpha \ln\left(1+\tau_{a_j}\right) + \phi\delta \ln(G_j) + \phi \frac{1-\delta}{\# a_j} \sum_{j \in a_j} \ln G_{j'} \tag{52}$$

$$- \left[(1-\phi)\alpha \frac{1}{\eta+1} + \phi\kappa\delta^2\right] \ln N_j - \phi\kappa \frac{1-\delta^2}{\# a_j} \sum_{j' \in a_j} \ln N_{j'} + \sigma\Theta_j^A$$

$$\ln r_j = \frac{1}{\eta+1} \ln N_j - \frac{1}{\eta+1} \ln\left(1+\tau_{a_j}\right) + \Theta_j^r \tag{53}$$

[28] The vote conditions derive from the following optimization problem: $\max_{\tau_j^H, G_j^s, G_j^f, G_j} \left(G_j^\delta \prod_{j' \in a_j} G_{j'}^{\frac{1-\delta}{|a_j|}}\right)^\phi C_j^{1-\phi}$ under the constraints $\zeta G_j^s + G_j^f = N_j h_j r_j \tau_j^H$, $G_j = \left(G^s\right)^\varphi \left(G_j^f\right)^{1-\varphi}$, $C_j = c_j^{1-\alpha} h_j^\alpha$, $c_j = (1-\alpha) w_j (1-\tau^W)$, $h_j = \frac{\alpha w_j (1-\tau^W)}{r_j (1+\tau_j^H)}$

with the transformed residuals

$$\Theta_j^r = \frac{\eta}{\eta+1}\theta_j^C + \frac{1}{\eta+1}\ln\frac{\alpha w_j(1-\tau^W)}{T_j}$$

$$\sigma\Theta_j^A = (1-\phi)\alpha\ln\alpha + (1-\phi)(1-\alpha)\ln(1-\alpha) + (1-\phi)\ln((1-\tau^w)w_j) - (1-\phi)\alpha\Theta_j^r + \phi\delta\Theta_j^G$$
$$+\phi\frac{1-\delta}{\#a_j}\sum_{j\in a_j}\Theta_{j'}^G + \theta_j^A$$

We define the following operators:

- $\underline{X}_j = X_j - \sum_{j\in a}\frac{X_j}{\#a_j}$
- $\overline{X}_j = \exp(\underline{\ln}(X_j))$
- $\underset{\sim}{X}_{a_j} = \sum_{j'\in a}\frac{X_{j'}}{\#a} - \sum_{a'}\sum_{j'\in a'}\frac{X_{j'}}{J\#a'}$
- $\widehat{X}_j = \exp(\underset{\sim}{\ln}(X_j))$
- $\hat{X}_j = X_j - \sum_{j'}\frac{X_{j'}}{J}$
- $\check{X}_j = \exp(\hat{\ln}(X_j))$

Applying $\underline{L}$ operator to equations 49, 50, 51, and 52 we get

$$\left[\sigma + (1-\phi)\alpha\frac{1}{\eta+1} + \phi\kappa\delta^2 - \phi\delta\right]\ln\frac{\overline{N_j^n}}{\overline{N_j^o}} = \phi\delta\Big(\ln\overline{N_j^o} - \ln\overline{G_j^o} + \ln\overline{w}_j\Big) + \frac{\eta}{\eta+1}(1-\phi)\alpha\ln\overline{1+\tau_j^o} \quad (54)$$

Applying $\underset{\sim}{L}$ operator to equations 50, 51, and 52 we get

$$\left[\sigma + \frac{(1-\phi)\alpha}{(\eta+1)} + \phi\kappa - \phi\right]\ln\frac{\widehat{N_a^n}}{\widehat{N_a^o}} = \phi\Big(\ln\widehat{N_a^o} - \ln\widehat{G_a^o} + \ln\widehat{w_a} + \ln\widehat{\tau_a^n} - \ln\widehat{1+\tau_a^n}\Big)$$
$$-\frac{\eta}{\eta+1}(1-\phi)\alpha\ln\frac{\widehat{1+\tau_a^n}}{\widehat{1+\tau_a^o}} \quad (55)$$

We have

$$\frac{N_j^n}{N_j^o} = \frac{\widehat{N_j^n}\overline{N_j^n}}{\widehat{N_j^o}\overline{N_j^o}}\frac{\sum_{j'}\widehat{N_{j'}^o}\overline{N_{j'}^o}}{\sum_{j'}\widehat{N_{j'}^n}\overline{N_{j'}^n}} \quad (56)$$

With equations 49, 54, 55, 56 and 50 – in this order – we get τ_j^n, N_j^n, G_j^n.

D.2 After the merger

Now we depart from our simplified version by assuming all cities within a municipal federation cooperate for the production of public goods. There is still no business tax and no state subsidies. Prior to the merger, residents vote for public goods in each city. Following the merger, residents vote for a new level of public goods pooling resources of all former member cities. To keep welfare comparable between pre- and post-reform situations, we assume that prior jurisdictions still exist for the purpose of labor and housing markets. The only thing that changes is the level at which public good is supplied.

Housing tax rates are fixed by MF council whose preferences reflect exactly those of all inhabitants of the MF. For a given MF a the council chooses the housing tax rate and the level of local public good G which maximize v_j – with j a city belonging to the MF – the budget constraint $\sum_{j' \in a} r_{j'} N_{j'} h_{j'} \tau^h_{j'} = G$. Importantly the optimization problem gives the same G and τ^H for all j belonging to a. Once G is chosen it is split and a share is allocated to each city. We assume in our reform that the allocation rule keeps the previous share unchanged, that is city j gets the share $\frac{G^n_j}{\sum_{j' \in a_j} G^n_{j'}}$ of G. We could, however, choose another rule, such as an egalitarian rule.

We note $N^m, G^m, v^m, r^m, \tau^m$ all the equilibrium variable in the merger case.

The new vote conditions are[29]

$$1 + \tau^m_a = 1 + \frac{\phi}{(1-\phi)\alpha} \tag{57}$$

$$G^m_j = \frac{\varphi^\varphi (1-\varphi)^{1-\varphi}}{\zeta^\varphi} \frac{G^n_j}{\sum_{j' \in a_j} G^n_{j'}} \sum_{j' \in a_j} \frac{\tau^m_{j'}}{1+\tau^m_{j'}} N^m_{j'} w_{j'} \alpha (1 - \tau^w) \tag{58}$$

τ^m_a and G^m_a are independant of the allocation rule chosen.

Equations 51, 52 and 53 still hold. We now rewrite $N^m, G^m, v^m, r^m, \tau^m$ as function of $N^n, G^n, v^n, r^n, \tau^n$.

Applying $\underline{L}$ operator to equations 49, 50, 51, 52, 57, and 58 we get

$$\overline{N^m_j} = \overline{N^n_j} \tag{59}$$

The allocation of population within any MF keeps constant.

[29] The vote conditions derive from the following optimization problem: $\max_{\tau^H_{a_j}, G_{a_j}, G^s_{a_j}, G^f_{a_j}} \left(\left[G_{a_j} w_j\right]^\delta \prod_{j' \in a_j} \left[G_{a_j} w_{j'}\right]^{\frac{1-\delta}{|a_j|}} \right)^\phi C_j^{1-\phi}$ under the constraints $\zeta G^s_{a_j} + G^f_{a_j} = \sum_{j' \in a_j} N_j h_j r_j \tau^H_{a_j}$, $G_{a_j} = \left(G^s_{a_j}\right)^\varphi \left(G^f_{a_j}\right)^{1-\varphi}$, $C_j = c_j^{1-\alpha} h_j^\alpha$, $c_j = (1-\alpha) w_j (1-\tau^W)$, $h_j = \frac{\alpha w (1-\tau^W)}{r_j (1+\tau^H_{a_j})}$.

Note that

$$G_j^m = \frac{G_j^n}{\sum_{j'\in a_j} G_{j'}^n} \sum_{j'\in a} G_{j'}^n \frac{\tau_{j'}^m}{1+\tau_{j'}^m} \frac{1+\tau_{j'}^n}{\tau_{j'}^n} \frac{N_{j'}^m}{N_{j'}^n}$$

$$= \left[\prod_{j'\in a_j} \frac{N_{j'}^m}{N_{j'}^n}\right]^{\frac{1}{\#a_j}} \frac{G_j^n}{\sum_{j'\in a_j} G_{j'}^n} \sum_{j'\in a_j} G_{j'}^n \frac{\tau_{j'}^m}{1+\tau_{j'}^m} \frac{1+\tau_{j'}^n}{\tau_{j'}^n} \frac{\overline{N_{j'}^m}}{\overline{N_{j'}^n}}$$

$$= \left[\prod_{j'\in a_j} \frac{N_{j'}^m}{N_{j'}^n}\right]^{\frac{1}{\#a_j}} \frac{G_j^n}{\sum_{j'\in a_j} G_{j'}^n} \sum_{j'\in a_j} G_{j'}^n \frac{\tau_{j'}^m}{1+\tau_{j'}^m} \frac{1+\tau_{j'}^n}{\tau_{j'}^n} \tag{60}$$

We define X_a such as

$$\frac{X_a}{G_j^n} = \frac{\sum_{j'\in a} G_{j'}^n \frac{\tau_{j'}^m}{1+\tau_{j'}^m} \frac{1+\tau_{j'}^n}{\tau_{j'}^n}}{\sum_{j'\in a_j} G_{j'}^n} \tag{61}$$

Applying $\underset{\sim}{L}$ operator to equations 50, 51, 52, 57, 58, 60 and 61 we get

$$\left[\sigma + (1-\phi)\alpha\frac{1}{\eta+1} + \phi\kappa - \phi\right] \ln \frac{\widehat{N_j^m}}{\widehat{N_j^n}} = \phi \ln \frac{\widehat{X_a}}{\widehat{G_a^n}} - \frac{\eta}{\eta+1}(1-\phi)\alpha \ln \frac{\widehat{1+\tau_a^m}}{\widehat{1+\tau_a^n}} \tag{62}$$

We have

$$\frac{N_j^m}{N_j^n} = \frac{\widehat{N_j^m}\,\overline{N_j^m}}{\widehat{N_j^n}\,\overline{N_j^n}} \frac{\sum_{j'} \widehat{N_{j'}^n}\,\overline{N_{j'}^n}}{\sum_{j'} \widehat{N_{j'}^m}\,\overline{N_{j'}^m}} \tag{63}$$

With equations 57,59, 60, 61, 62, 63 and 58 – in this order – we get τ_j^m, N_j^m, G_j^m.

Eventually we have

$$v_j^m - v_j^n = \phi\delta \ln \frac{G_j^m}{G_j^n} + \phi\frac{1-\delta}{\#a_j} \sum_{j\in a_j} \ln \frac{G_{j'}^m}{G_{j'}^n} - \left[(1-\phi)\alpha\frac{1}{\eta+1} + \phi\kappa\delta^2\right] \ln \frac{N_j^m}{N_j^n} \tag{64}$$

$$- \phi\kappa\frac{1-\delta^2}{\#a_j} \sum_{j'\in a_j} \ln \frac{N_{j'}^m}{N_{j'}^n} - \frac{\eta}{\eta+1}(1-\phi)\alpha \ln\left(\frac{1+\tau_{a_j}^m}{1+\tau_{a_j}^n}\right)$$

D.3 Welfare comparison

We define social welfare as

$$W = \mathbb{E} \max_j u_{ij} = \mathbb{E} \max_j \left(v_j + \epsilon_{ij}\right)$$

Since idiosyncratic shock follow a Gumbel law, we have[30]

$$W = \sigma\zeta + \sigma \ln\left(\sum_j e^{\frac{v_j}{\sigma}}\right)$$

[30] ζ is the Euler constant.

hence

$$W^o = \sigma\zeta + \sum_j \frac{v_j^o}{J} + \sigma \ln\left(\sum_j \exp\left(\frac{v_j - \sum_j \frac{v_j^o}{J}}{\sigma}\right)\right)$$

Note that $\check{N}_j^n = \exp\left(\frac{\widehat{v_j^n}}{\sigma}\right)$ therefore

$$W^n = \sigma\zeta + \sum_j \frac{v_j^n}{J} + \sigma \ln\left(\sum_j \check{N}_j^n\right)$$

and

$$W^m = \sigma\zeta + \sum_j \frac{v_j^n}{J} + \sigma \ln\left[\sum_j \check{N}_j^n \exp \frac{v_j^m - v_j^n}{\sigma}\right]$$

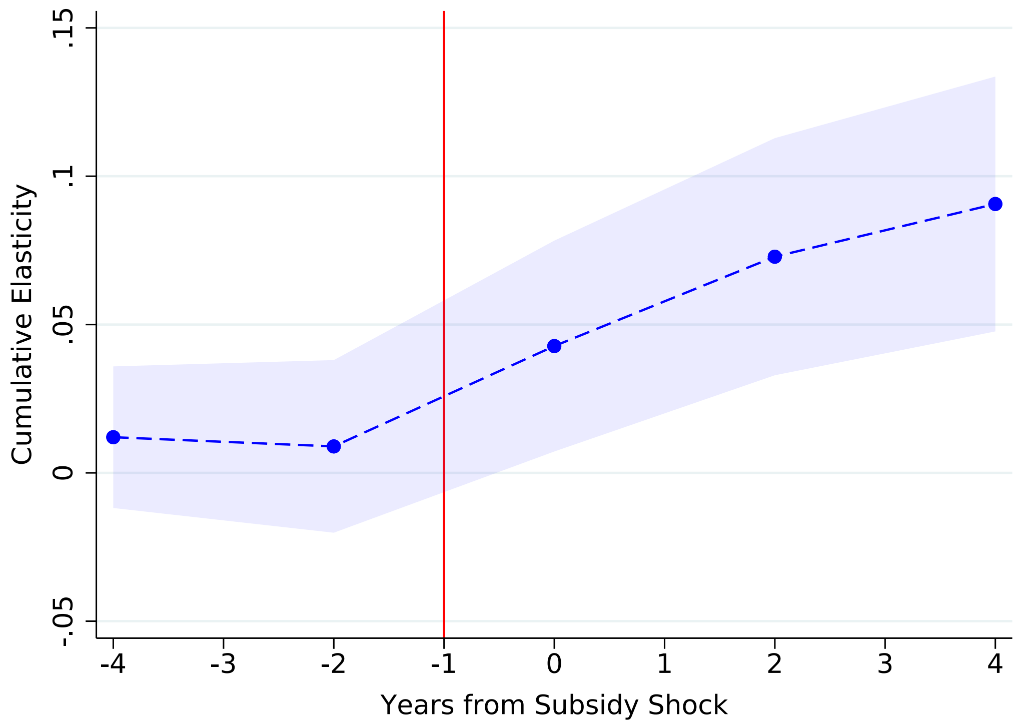
Eventually

$$W^m - W^n = \sigma \ln\left(\frac{\sum_j \check{N}_j^n \exp \frac{v_j^m - v_j^n}{\sigma}}{\sum_j \check{N}_j^n}\right) \tag{65}$$

D.4 Welfare estimation

For the estimation of welfare change, we use parameters estimates of section 5 and their estimated variance-covariance structure. As we have as many parameters estimates as we have IV specifications, we take the average across specifications for each parameter to compute the point estimate for welfare change. We compute Monte-Carlo standard errors by simulating 10,000 new values for each parameter using the estimated variance-covariance matrix. We then get the mean estimate for κ, ϕ, δ, σ across specifications. We then estimate the welfare impact of a reform for each of these simulated set of parameters and compute percentile-based standard errors. As for η and α, we take standard values from the literature. In our baseline scenario we take $\eta = 0.2$ and $\alpha = 0.3$.

Figure 14: Changes in (Public Employees)/ (20-65 Population)



Note: This Figure plots the coefficient of regressions similar to section 4 regressions. The dependent variable is the proportional change in the absolute share of public employees in city population $\Delta \ln(s_p)$ and the explanatory variable is the within-MF subsidy shock $\Delta \ln(S/\overline{S})$. Standard errors are clustered at the MF level. We report the 5% confidence bands.