The Role of Local Public Goods for Fiscal Policy in the Spatial Economy*

Fabian Bald †   Marcel Henkel ‡

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Abstract

Regional governments often employ significant financial resources as investments in public goods at the local level. Apart from affecting the attractiveness of their jurisdiction, local fiscal expenditure also has the potential to stimulate local employment via "fiscal multipliers". We exploit exogenous variation in the size of public funds and interregional fiscal transfers to estimate the size of these local employment shifters. To assess the aggregate effects of public policies on employment and regional sorting, we use these multipliers as input into a spatial general equilibrium model with multiple types of workers. In our model, workers are differently affected by local fiscal budgets and local public goods provision in their labour supply decisions. Counterfactual simulations suggest that the inclusion of local labour supply responses as an additional adjustment channel leads to distinct quantitative and qualitative effects on aggregate welfare and productivity in a spatial model with worker mobility.

Keywords: local public goods, labour force participation, taxes, transfers, gender

JEL: H4, H7, J1, J2, J6, R2, R5

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†University of Duisburg-Essen, RGS

‡University of Bern, CRED

A Introduction

Many governments employ substantial fiscal funds to reduce spatial disparities by stimulating distressed local economies and labour markets. Spatial policies transfer tax revenue from high- to low-capacity regions and help providing public goods and services, such as education and infrastructure, at the local level.[1] Redistributive policies and local public expenditures have the potential to decrease spatial disparities and increase local labour force participation. Especially households in high non-employment areas may benefit from such public policies, as the local labour supply adjusts more elastically, and fewer people migrate to these places, putting less pressure on local congestion and prices (Austin et al., 2018; Bartik, 2020).

Traditionally, the urban economics literature has highlighted the vanity of place-based policies (Glaeser and Gottlieb, 2008; Kline and Moretti, 2014). In particular, it may well be that employment gains in one area are simply the employment losses elsewhere or get capitalized into land values. However, in the presence of spatially-variant spillovers from fiscal expenditure to local labour supply ("fiscal multipliers")[2] spatial policies may well increase efficiency and generate aggregate benefits. Nonetheless, the literature concerned with the optimal design of spatial policies under worker and firm mobility in general equilibrium (Albouy et al., 2019; Fajgelbaum et al., 2019; Fajgelbaum and Gaubert, 2020) has abstracted from accounting for this local labour force participation channel via fiscal policy in their analytical framework.[3]

In this paper, we study how public expenditures may induce higher labour force participation, decrease spatial disparities and increase overall welfare. In particular, we analyze under which conditions spatial policies enhance equity and simultaneously lower the efficiency costs of redistribution (Gaubert et al., 2021). We first provide empirical evidence on the existence and relevance of a labour force participation channel whereby local fiscal policies increase local economic activity via employment multipliers. Exploiting a unique combination of quasi-experimental variation in local fiscal budgets with detailed administrative labour market data on German districts, we determine the labour force participation responses of heterogeneous worker groups at the local level. These reduced-form estimates, however, do not account for general equilibrium effects or spatial sorting induced by the fiscal spending shocks.

We, therefore, incorporate these empirical estimates into a spatial general equilibrium

[1] For example, Henkel et al. (2021) calculate that the German government shifts more than 50 billion Euros across space per year via various equalization schemes. Sub-federal jurisdictions in Germany spent 145 billion Euros, or 5% of total German GDP, just on public education and childcare alone in the year 2020 (Eurydice, 2020).

[2] Leduc and Wilson (2017), Garin (2019) and Buchheim and Watzinger (2022) focus on the local employment effects of infrastructure investments. While Gadenne (2017) provides similar evidence for developing economies, Corbi et al. (2019) focus on the labour market effects of federal transfer payments. Ramey and Zubairy (2018) provides aggregate multipliers for the US economy.

[3] A notable exception is Kline and Moretti (2013) where non-employment arises from search frictions. In such a framework, spatial redistribution policies may be beneficial.

model in the spirit of Rosen (1974) and Roback (1982). But, we add essential components with important implications for the design of spatial policies. First, governments in every region provide local public services, whose costs are financed by local taxes and spatial transfers (Henkel et al., 2021). Second, and more crucially, we extend the framework to account for extensive labour supply decisions, which account for non-convexities in private and public goods consumption and workers' preferences for market work.

As in recent strands of general-equilibrium spatial research: Regions and sectors differ fundamentally concerning their exogenous productivity and amenity levels, as well as bilateral trade costs. Heterogeneous workers sort across local labour markets (Mcfadden, 1974; Diamond, 2016; Rossi-Hansberg et al., 2019; Ahlfeldt et al., 2020). Interactions across agents give rise to spatial spillovers. For example, productivity levels react endogenously to the size of the local labour force through agglomeration externalities.[4]

We argue that it is crucial to additionally account for the non-convexities created by the labour force participation channel in investigating the design of spatial policies. Spatially immobile non-employed workers adjust their extensive labour supply decisions in response to local public expenditures, which affects the size of the local labour force and the strength of productivity spillovers.

Inefficient extensive labour supply decisions impose a classical "fiscal externality" (Flatters et al., 1974; Albouy, 2012). We show that this creates additional agglomeration forces via higher tax revenues and spatial transfers, which entails additional efficiency costs. Moreover, higher relative congestion put on local public goods consumption by employed workers relative to non-employed workers works as an additional dispersion force. The precise interplay of spatial spillovers and congestion forces in local public good consumption defines which spatial policies are efficient. This concept captures the notion that workers who adjust their labour supply are indifferent at the margin but do not consider the impact of their (extensive) labour supply decisions on fiscal budgets and the rest of the economy.

An essential feature of the model is the presence of many sectors within each local labour market. Hence, in constructing our quantitative spatial general equilibrium model, we include the costly participation decisions of heterogeneous worker groups to join either of the market sectors based on their comparative advantage or type-specific preferences (Caliendo et al., 2019; Hsieh et al., 2019; Burstein et al., 2020). Our contribution in this paper is to focus on the additional labour market friction that prevents workers from joining the local labour market, because there are costs of market employment (Cogan, 1981; Blundell and Shephard, 2012; Kleven and Kreiner, 2006), or since workers dislike to work (Fajgelbaum et al., 2019; Chauvin, 2018).

On the production side, firms use the human capital of heterogeneous workers as well as non-tradable land and structures as inputs to produce intermediate goods in different sec-

[4] In such a framework with spatial spillovers, it has been shown how inefficient spatial sorting may lead to substantial welfare costs in the decentralized equilibrium. In particular, Fajgelbaum and Gaubert (2020) define the spatial policies that allow tackling these inefficiencies.

tors, which are imperfectly tradable across regions and used as inputs for a non-tradable final consumption good and local public goods in each location (Caliendo et al., 2018; Rossi-Hansberg et al., 2019). Local governments own the land and structures and pay their profits into a nationwide portfolio supervised by the federal government (Caliendo et al., 2019). Each local government receives a constant share from the portfolio, thereby rationalizing observable transfer payments across the economy and levels of government. Aggregate labour income at the regional level is taxed and, together with transfers from the federal government, used to provide non-tradable and rivalrous public goods by local governments (Fajgelbaum et al., 2019; Fajgelbaum and Gaubert, 2020). The federal government runs a substantial fiscal re-distribution scheme and shifts funds from high productivity regions to poorer parts of the spatial economy. To fit the transfers to their real-world equivalent, we use the procedure in Henkel et al. (2021).

Public policies may, in principle, increase local employment either directly via "local multipliers effects" (Moretti, 2010, 2011), or indirectly by reducing the opportunity cost of non-employment (for example, by increasing the skills of the local workforce, expanding public childcare, or offering after-school programs). In particular, we model employment multipliers as local labour supply shifters. Our framework features a trade-off between public goods provision and local labour force participation. Financing local public goods requires higher tax rates, which disincentivizes workers to supply labour by decreasing real wage income (henceforth, the "income effect"). At the same time, higher local public expenditures increase the size of the local labour force through the "substitution effect" and further fiscal multipliers. In the long run, worker mobility enhances this trade-off since migration inflows enlarge the size of the local labour force and, in turn, tax revenues but simultaneously "congest" public goods consumption as long as public services are rivalrous. Since the income and substitution effects work in opposing directions, predictions about the impact of the fiscal spending on local labour force participation rates are a priori ambiguous.

We, therefore, quantify our spatial general equilibrium model using the fiscal re-distribution scheme across 141 local labour markets in Germany in 2008. We incorporate two worker groups to study the spatial distribution and extensive labour supply decisions of female and male workers. We construct six market sectors (four tradable and two non-tradable) and one home market sector. The model allows us to structurally identify the labour market friction that prevents workers from joining the local labour market because of costs of market employment, and the participation costs to join any market sector within a local labour market. Since the labour market frictions can be affected by public policies in the model, we inform our model with reduced-form estimates of the elasticities of worker extensive labour supply with respect to local fiscal capacities.

Local fiscal capacities are not exogenous to economic and fiscal conditions. Hence, it is generally challenging to identify a causal effect of public expenditures on the local economy. We, therefore, leverage the specific institutional setting of the German fiscal equalization system to rely on local population counts to determine the financial needs of local jurisdictions and transfer rates across regions. In 2011, a nationwide and compulsory survey on several demographics of the German population (the "Census") induced sizable adjustments in official population registers with a significant impact on the fiscal re-distribution scheme in Germany. We use these Census revisions to estimate the causal effects of fiscal budget shocks on local labour markets. Thereby, we exploit that the 2011 Census population revision led to quasi-exogenous shocks to the interregional fiscal redistribution scheme. We define treated regions as locations that have received a Census shock one standard deviation below the median, while all regions with a Census shock above the median are our control regions.

Following Serrato and Wingender (2016) we use a Treatment Effect framework to estimate the causal effect of the Census shock on local public finance and labour markets. We find that the Census shock induced a permanent shock to fiscal transfers and local government budgets. One per cent larger increase in local population counts led to approximately 60 Euros higher fiscal transfers per capita. Put differently, an increase of the Census shock by one standard deviation led, on average, to 15 per cent higher fiscal transfers per capita after the Census shock. This implies that fiscal capacities per capita persistently fell by around 2% in treated regions compared to control regions after the Census shock.

We further investigate the heterogeneous labour force participation responses to these fiscal budget shocks, employing administrative linked employer-employee data. We find that non-employment rates in negatively treated regions decrease by around 0.8 percentage points relative to control regions following the fiscal budget shock. Noteworthy, female workers respond more elastically to these fiscal budget shocks than male workers.

To highlight the predictions from our model framework we lastly compute counterfactual scenarios to quantify the effects of a large-scale government investment program, whose financing re-distributed funds across the economy. In particular, we quantify the general equilibrium effects of a German public expenditure program from 2008, whose primary goal was to provide the legal right to a public childcare place for all children over the age of one in Germany. We focus on this specific public investment program since: firstly, the local investments were mainly financed by intergovernmental transfers, whereas the tax burden associated with the investments fell equally on all workers; and secondly, the specificity of the underlying laws allows determining the subsequent distribution of federal funds across the economy. We thus exploit the circumstance that its local impact depended on the already existing number of local childcare places and the size of the female labour force to assess the size of transfers from the federal to regional jurisdictions associated with this specific investment program. Lastly, with its potential on affecting (especially female) labour supply, it gives additional support for our modelling choice with two distinct worker groups that are differently impacted by the provision of public goods.

Public childcare was already more firmly established in Eastern Germany before 2008, especially because of its long-lasting socialist history and path-dependency in gender role attitudes (Boelmann et al., 2020). Since richer parts of the German economy contributed more towards the set-up of the government program, we nonetheless observe substantial re-distribution of funds from urban areas in the South towards rural and Eastern German regions. Since increased fiscal funds allow financing more public goods, our counterfactual simulations predict sizable worker flows, with donor regions losing about 33,000 inhabitants in the transition to a new long-run spatial equilibrium. In-migration imposes downwards pressure on local real wages, which acts as a congestion force in the traditional Rosen-Roback framework.

As argued above, the income and substitution effect work in opposite directions, such that the effect of local fiscal budget shocks on labour force participation rates is a priori unclear. In our counterfactual simulations, however, the substitution effect dominates such that overall labour force participation (marginally) increases overall. This effect is particularly pronounced in recipient regions. As a result, we find that welfare of both worker types increases, whereas overall production slightly decreases between the two equilibria as workers are incentivized to migrate to low productivity regions and sectors in the new equilibrium.

Related Literature. We build on a large literature which has studied the optimal design of policy instruments in the presence of externalities and worker (Albouy et al., 2019; Colas and Hutchinson, 2021; Fajgelbaum and Gaubert, 2020; Fu and Gregory, 2019; Gaubert et al., 2021; Rossi-Hansberg et al., 2019) or firm mobility (Fajgelbaum et al., 2019; Serrato and Zidar, 2016). In this paper, we jointly study the misallocation of workers across region-sector pairs and the extensive margin of labour supply. We show that government programs may shift labour supply across both dimensions. In particular, we highlight an additional agglomeration force which runs through the fiscal budgets of local and federal governments.[5] At the same time, employed workers may exhibit additional congestion costs on a region's amenities or public goods. These externalities imply added sources of inefficiency with distinct qualitative and quantitative implications for the design of spatial policies.

We hereby also connect to literature concerned with the evaluation of place-based policies in reduced-form (Kline and Moretti, 2013, 2014; Criscuolo et al., 2019).[6] Relative to this literature, we focus on the general equilibrium effects and optimality of public policies in the spatial economy.

With our focus on local labour force participation in quantitative models with worker mobility, this paper also relates to the growing literature that incorporates unemployment in quantitative trade (Adão et al., 2022; Carrère et al., 2020; Kim and Vogel, 2021) or spatial (Bilal, 2020; Caliendo et al., 2019) models. In this paper, we focus on the impact of local fiscal expenditure on local labour supply and worker sorting and thus add a public

[5]With their labour force participation decisions, local workers ignore their impact on both local and federal fiscal budgets with additional implications for local policy choice. See Agrawal et al. (2022) for a recent literature overview.

[6]See also Neumark and Simpson (2015) and Ehrlich and Overman (2020) for an overview of this literature.

finance component to this growing literature.

In the empirical sections of this paper, we assess the labour supply responses of heterogeneous workers to a fiscal expenditure shock. In this sense, we relate to studies that estimate "geographic cross-sectional fiscal spending multipliers" (Chodorow-Reich, 2019; Nakamura and Steinsson, 2014).[7] In this paper, we combine quasi-random variation in local fiscal budgets induced by Census shocks (Helm and Stuhler, 2021; Serrato and Wingender, 2016) with rich administrative labour market data to estimate heterogeneous effects across different worker groups. In particular, we argue that female workers' labour supply may react more elastically to local public good provision.

Indeed, recent empirical literature documents how a higher provision of different components of local public goods increases labour force participation, especially among female workers. Indeed, most of the empirical literature tends to find significant positive effects of the availability of public childcare facilities on labour supply decisions, particularly for young mothers. [8] Besides, public spending on nursing homes for the elderly has positive employment effects for older women since they are more likely to care for their elderly relatives (Crespo and Mira, 2014). Finally, investments in public transport infrastructure via decreased commuting costs (Le Barbanchon et al., 2021), faster broadband internet facilitating working from home (Dettling, 2017) and increasing worker productivity may have higher positive employment effects, especially for female workers. This paper bridges a gap between this empirical literature, which credibly identifies causal effects of public policies on extensive labour supply, and general equilibrium models, that allow precise predictions about counterfactual outcomes and welfare in the spatial economy.

The rest of the paper reads as follows. Section B.1 describes the institutional setting of local public goods provision and fiscal equalization in Germany, as well as the 2011 Census shock. Section B.2 presents empirical evidence of a positive relationship between employment and fiscal capacities at the local level. We introduce the spatial model with heterogeneous agents, fiscal transfers and multipliers in Section C. Section D explains how we quantify the model for Germany. The counterfactual analysis is presented in Section E and Section F concludes.

B Stylized Empirical Facts

Before introducing the theoretical model, we begin by briefly documenting several empirical facts about the impact of fiscal budget shocks on local labour markets in Germany. Identifying a causal effect of public expenditures on the local economy imposes one fundamental challenge: the change in local fiscal capacities is typically not exogenous to local economic and financial conditions. One key feature underlying fiscal equalization in Germany is the reliance on population counts in calculating fiscal needs and trans-

[7] Chodorow-Reich (2019) provides an overview of recent methodological advances in the literature on "geographic cross-sectional fiscal spending multipliers".

[8] See Blau and Currie (2006) and Olivetti and Petrongolo (2017) for a literature overview.

fer rates per region. Updates to the official population numbers after a nationwide and compulsory survey (the "Census") in 2011 directly affected the fiscal equalization scheme. We exploit this quasi-experimental variation in the size of fiscal transfers and local fiscal budgets and provide causal evidence that the Census shock in 2011 affected the economy through heterogeneous labour market adjustments, in particular, via changes in labour force participation.

All data sets we use in this section, and a detailed description of all data preparation steps, appear in Section H.1 of the Online Appendix.

B.1 Fiscal Redistribution and Population Counts in Germany

According to the German Constitution, the Federal government and the 16 Federal States are independent fiscal jurisdictions. The municipalities count within the framework of the Financial constitution as part of the Federal States. According to Article 72 of the German Constitution, living conditions should be "equivalent" across all regions in the country. To ensure that the local jurisdictions have sufficient fiscal capacities to fulfill this task, the Federal government and States distribute tax revenues across the different government layers and allocate them to the single States and municipalities according to a complicated set of rules.

More than 53.5 billion Euros, or 10% of German GDP, is shifted across the various governmental layers and jurisdictions each year, especially from the more affluent parts in Southern and Western Germany to East Germany (Henkel et al., 2021). Generally, the fiscal budgets of many jurisdictions rely heavily on the redistribution scheme such that in several East German districts, fiscal transfers account for more than 60 % of total income. Panel (a) of Figure 1 displays the spatial distribution of fiscal transfers for the year 2010.

In our empirical approach, we rely on the specific feature that the official local population counts play a significant role in the allocation of fiscal revenues: a larger number of inhabitants implies a higher need for additional funds and is, therefore, on average, associated with a higher amount of transfer payments for recipient regions. The reverse tends to be true for net donor regions across the redistribution scheme. Similarly to Helm and Stuhler (2021) and Serrato and Wingender (2016), we exploit the fact that regional population adjustments in official population registries following a nationwide census led to sudden and unexpected shocks to the fiscal redistribution scheme.[9]

Before the official adjustments in population records following the Census, local governments approximated their population counts via extrapolations from population registries at the municipality level ("Bevölkerungsfortschreibung"). These projections, however, were likely to deviate from actual regional population levels each year. Since the popula-

[9]Because of its substantial costs, a nationwide census takes place only erratically. Indeed, it took almost 25 years between the previous Census in 1987 and the Census in 2011, which took place only after lengthy discussions on its usefulness and costs and under substantial pressure from an EU mandate. Helm and Stuhler (2021) focus on the 1987 Census and carry out their analysis on the level of German municipalities. We, however, focus on the 2011 Census. Due to data limitations, however, we analyse the data at the more aggregated county or labour market delineation.

tion re-counts occurred only several decades later, these deviations accumulated over time, where the exact size was unlikely to be anticipated. The 2011 Census led to unexpected shocks to regional populations, with Germany "losing" almost 1.5 million inhabitants in the aggregate (1.8 % of its total population) between the end of 2010 and May 2011 when the results of the Census were published. The updates of the population records, in turn, affected the calculation of the prospective fiscal transfers.

We define the Census shock $\Delta \ln \text{Census}_{i,2011}$ as the difference between local (log) population counts at the end of 2010 and the results of the most recent Census in May 2011, such that

$$\Delta \ln \text{Census}_{i,2011} \equiv (\ln L_{i,\text{Census}} - \ln L_{i,2010}) * 100.$$

We display the spatial heterogeneity in the size of the Census shock both within and across German states in Panel (b) of Figure 1. The Census shock was spatially differentiated, with some counties losing up to 7 % of their population and others gaining 5 %.

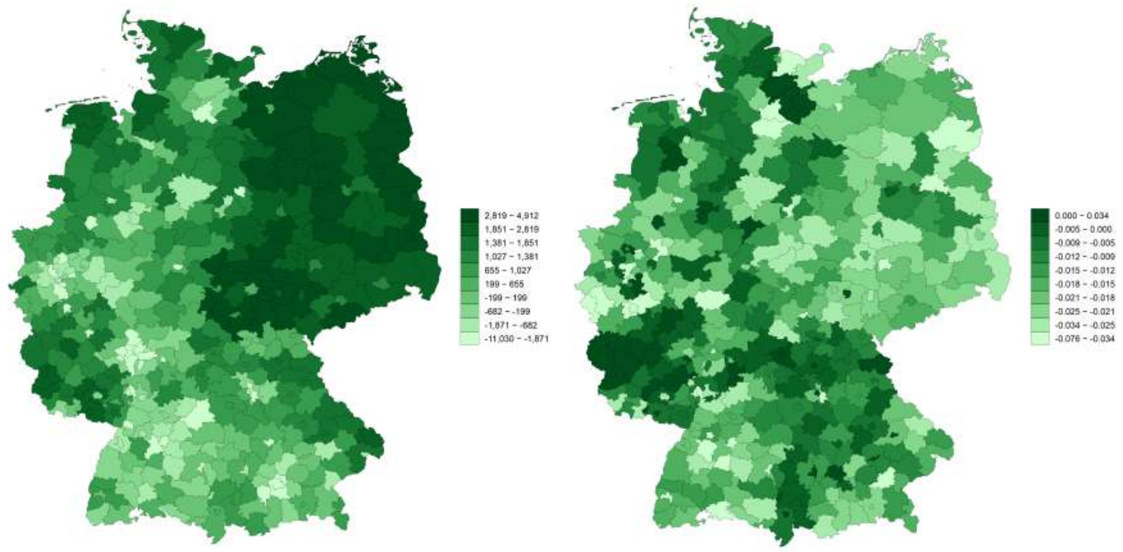
In our preferred specification, we define treated regions as locations that have received a Census shock one standard deviation below the median. All regions with a Census shock one standard deviation above the median are our control regions. Overall, we argue that since the calculation of the size of fiscal transfers uses population counts, the Census shock in 2011 induced one-off and quasi-exogenous shocks to the interregional fiscal redistribution scheme.

B.2 Empirical Approach

In this section, we estimate the reduced-form elasticities of worker extensive labour supply with respect to local fiscal capacities. Given the presented facts above, we could argue that the Census Shock induced unexpected and random variation in the fiscal transfer system and, in turn, local fiscal capacities. To identify a causal effect on the local economy, it would then suffice to rely on the following identifying assumption: the Census shock was purely due to erratic accounting or population forecasts but, as such, not correlated with other economic or fiscal shocks to local labour markets. We are, however, concerned about underlying local economic trends that might correlate with the intensity of the Census shock and simultaneously predict local public finance and employment dynamics in post-Census periods.

Following Serrato and Wingender (2016) we, therefore, use a Treatment Effect framework to estimate the causal effect of the Census shock on local public finance and labour markets, which allows us to model selection into treatment without a priori imposing any functional approach for the dependent variable. In particular, we allow the treatment status to depend on lagged outcome variables and rely on a separate identifying assumption: we model selection into treatment as a function of controls, including lagged growth of the outcome variable. We then obtain causal estimates, e.g., the employment elasticities to local public expenditures, as long as our control variables capture all factors that simultaneously affect the probability of becoming a treated region and outcome growth. In short,

Figure 1: Spatial disparities in fiscal transfers and the Census shock



(a) Fiscal transfers per capita

(b) Census shock

Notes: Panel (a) of this figure plots the geographical pattern of fiscal transfers per capita at the end of the year 2010 across the 401 German counties ("Kreise und kreisfreie Städte). Legend labels are in 2010 Euros. Panel (b) plots the geographical pattern of the Census shock (the difference between (log) population counts at the end of the year 2010 and the results of the Census in May 2011) across the 401 German counties ("Kreise und kreisfreie Städte). Darker shading indicates higher values.

it matches regions with distinct Census shocks on their growth path before treatment.

To implement the Treatment Effect approach, we use two approaches proposed by Acemoglu et al. (2019). Borrowing the notation from Acemoglu et al. (2019), we let $Y_{i,t}^{g,s}(d)$ be the natural logarithm of the potential outcome of the dependent variable for region i at time period $t+s$, depending on whether it received a treatment $d \in \{0,1\}$ at time period t.[10] We furthermore define the potential growth in (log) dependent variables between the pre-shock period $t-1$ and period $t+s$ as $\Delta Y_{i,t}^{g,s}(d) = Y_{i,t}^{g,s}(d) - Y_{i,t-1}^{g}$.

We first estimate the propensity score of being in the treatment group with a probit regression, where we use lags of the (log) outcome variable as explanatory variables. Using the (inverse) propensity scores $\mathcal{W}_{i,t}$ as weights, the inverse probability-weighted treatment effect of the treated (IPW) is thus $\hat{\beta}^{g,s} = \hat{\mathbb{E}}\left[\mathcal{W}_{i,t}\left(\Delta Y_{i,t}^{g,s}(1) - \Delta Y_{i,t}^{g,s}(0)\right)\right]$.

Alternatively, we implement a "doubly-robust" (IPWRA) estimator that simultaneously implements the inverse probability re-weighting described above but adjusts poten-

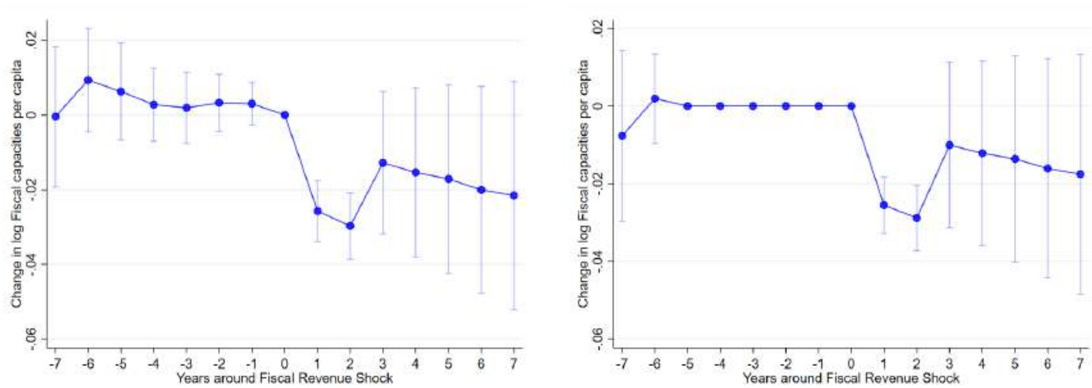
[10] We only focus on binary treatments $d \in \{0,1\}$, as defined in sub-section B.1. We abstract from heterogeneous effects of fiscal spending, depending on the qualitative sign of the shock as highlighted in Barnichon et al. (2022), but focus solely on negative fiscal shocks. Note that in our case, the Census shock in 2011 implied that the majority of regions suffered negative spending shocks, while only a smaller fraction of regions received a positive shock.

tial outcomes of the dependent variable for treated regions with a linear regression. We use the same controls as for the IPW estimator to implement the linear regression adjustment. The consistency of our estimates then only relies on the correct model specification for either (i) the probability of becoming a treatment region after the Census shock or (ii) counterfactual outcomes in non-treated regions. Hence, as long as either the probit regression or the linear adjustment of counterfactual outcomes is correct, our estimated coefficients are consistent (Imbens and Wooldridge, 2009).

B.2.1 Local Public Finance

Figure 2 presents the overall dynamic fiscal capacity response to the Census shock in 2011. The graph documents a sharp and significant negative response of fiscal capacities per capita after the Census shock in 2011. In particular, fiscal capacity per capita fell by around 2% in treated districts one to seven years after the Census shock compared to regions with an above-median Census shock. The average treatment effect of the treated (ATT) of the Census shock on fiscal capacities per capita is about 1.7%. This effect is almost immediate: the fiscal capacities decrease in the first year after the Census shock. Finally, this effect is persistent in the long run: we do not observe a reversal of pre-treatment fiscal capacity growth rates.

Figure 2: Treatment Effect of Census shock on Fiscal capacities per capita



(a) Inverse Probability Weighting (IPW)

(b) Inverse Probability Weighting and Regression Adjustment (IPWRA)

Notes: This Figure plots the coefficients and 95% confidence intervals of the Treatment Effect framework regressions on the natural logarithm of growth in fiscal capacities per capita. In Panel (a), we show the event study coefficients of inverse probability weighting (IPW) with a probit treatment model. Panel (b) shows the coefficients of a "doubly robust" estimator (IPWRA), which combines inverse probability weighting with a probit treatment model and a linear outcome model. We use lags of the outcome variable and period effects as explanatory variables for the treatment and outcome models. Event periods are defined relative to the year of the Census shock (e.g., $t = -1$ in 2011). Standard errors are bootstrapped and clustered on the level of regions.

B.2.2 Non-Employment

Figure 3 plots the dynamic non-employment effects based on the Treatment Effect approach.[11] The coefficients from the inverse probability weighting (IPW) show that there are no discernible pre-trends after controlling for lagged outcomes. However, after the Census-induced fiscal budget shock the non-employment rates increase by approximately 10 % relative to the control group regions. Interestingly, we observe slightly smaller and less significant coefficients for male than for female workers.

In columns (3) and (4) of Table 2, we display the coefficients of the IPWRA approach with five lags. The coefficients are very similar compared to estimates from inverse probability weighting. The standard errors of male coefficients, however, are sizeably smaller, which implies that the point estimates become highly significant at all commonly-used levels.

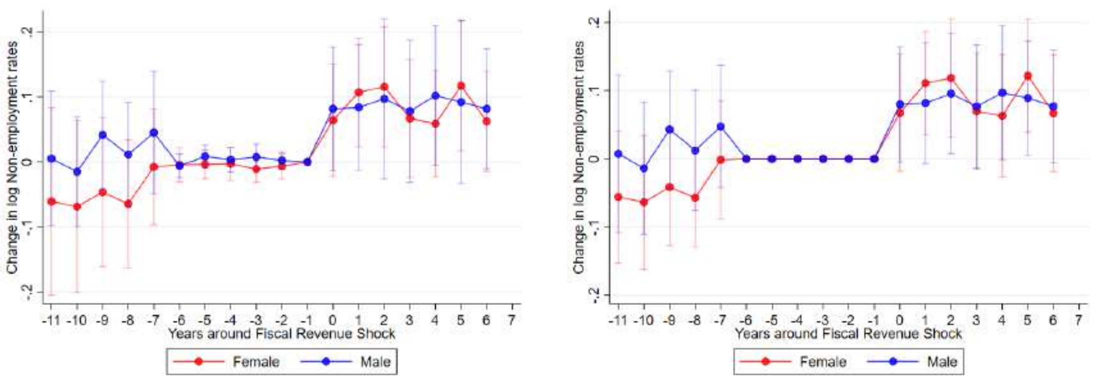
To better understand our findings, we also compare the treatment effects framework with a simple triple difference-in-difference estimation (see subsection H.4 in the Appendix). Accordingly, we find that labour force participation rates in negatively treated regions decrease by around 10 % relative to control regions following the fiscal budget shock. Given initial non-employment rates, this translates into a decrease of approximately 0.8 percentage points.

To sum up, we first show that an below-median Census shock was associated with smaller fiscal capacities per capita. We then estimate the impact of these fiscal budget shocks on local economies and, in particular, on extensive labour supply. In doing so, we document that variations in local fiscal budgets affect the extensive labour supply decisions of heterogeneous worker groups. This holds in a setting where the Census shock generated random spatial variation in fiscal budgets, which allows identifying the causal employment effect when time-varying fiscal capacity shocks are exogenous to local economic conditions.

Our estimates, however, do not account for general equilibrium effects or spatial sorting induced by the fiscal spending shocks. In the next section, we, therefore, incorporate these reduced-form estimates into a spatial quantitative model featuring heterogeneous workers that react differently to fiscal revenue shocks and local public goods provision in extensive labour supply. We are thus able to identify the general equilibrium effects of public spending on local labour markets while accounting for regional and sectoral sorting of heterogeneous workers as well as local employment effects.

[11] Table 2 in the Online Appendix displays the detailed estimates.

Figure 3: Treatment Effect of Fiscal Budget shocks on Non-employment



(a) Inverse Probability Weighting (IPW)

(b) Inverse Probability Weighting and Regression Adjustment (IPWRA)

Notes: This Figure plots the coefficients and 95% confidence intervals of the Treatment Effect framework regressions on the natural logarithm of growth in non-employment probabilities. In Panel (a), we show the event study coefficients of inverse probability weighting (IPW) with a probit treatment model. Panel (b) shows the coefficients of a "doubly robust" estimator (IPWRA), which combines inverse probability weighting with a probit treatment model and a linear outcome model. We use lags of the outcome variable and period effects as explanatory variables for the treatment and outcome models. Event periods are defined relative to the year of the Census shock (e.g., $t = -1$ in 2011). Standard errors are bootstrapped and clustered on the level of regions.

C A Quantitative Spatial Model with Extensive Labour Supply of Heterogeneous Workers

A continuous mass L of individuals live and work in J regions and S sectors (one of which is the home market sector). They are bound to a specific group $g \in G$ featuring a total number of L^g workers. Before workers decide whether to work in market sector $u \in M$ or stay in the home market sector h, they move across regions and the $M \subset S$ market sectors. Workers, however, incur participation costs in terms of utility when moving across the market sectors within a local labour market. Moreover, workers differ in their tastes for distinct region-sector pairs and their disutility of working.

Each worker ω is characterized by a $2 * J * M$-dimensional vector of idiosyncratic draws (Ψ, φ), where Ψ is a vector of preferences for living and working in a specific region-sector pair $\{i, u\}$ and φ is the vector of the non-pecuniary cost ("dis-utility of working") the worker faces when joining the labour force in region i and market sector u. F^g and G^g denote the distributions of these two independent idiosyncratic components.

In this sense, labour supply decisions incorporate choices along allocative and extensive margins. On the allocative margin, each worker chooses one of the region-sector pairs $\{i, u\}$ for living and working; we denote the spatial sorting and sectoral selection decision of workers of group g by $L^g_{i,u}$. The extensive margin entails deciding whether to join the home market sector h or remain in the labour force and market sector u in region i. We let $L^g_{h|i,u} \leq L^g_{i,u}$ denote the number of non-employed workers, who chose region i and market sectors u as their place of work in a first stage.

All formal proofs and a detailed description of all derivations in this section appear in Section I.1 of the Online Appendix.

C.1 Workers

Preferences. Each worker ω of group g derives utility from consuming final goods, public services, and from staying in a given region $i \in J$ and sector $s \in S$. Conditional on having chosen the region-sector pair $\{i, u\}$, the budget-constrained worker chooses consumption bundles $C_{s,u'|i,u}$ of local final goods at prices $P_{i,u'}$ in all market sectors $u' \in \{1, ..., M\}$ to maximize utility according to

$$\max_{\{C^g_{s,u'|i,u}\}^M_{u'=1}} \eta^g_{s|i,u}(\omega) \left(\frac{R_{s|i,u}}{L^\chi_i}\right)^\alpha \left[\prod_{u'=1}^{M} (C^g_{s,u'|i,u})^{\beta^C_{u'}}\right]^{1-\alpha} \Psi^g_{i,u}(\omega) \quad \text{s.t.} \quad \sum_{u'=1}^{M} P_{i,u'} C^g_{s,u'|i,u} = I^g_{s|i,u},$$

where $R_{s|i,u}$ denotes the public good provision by the local government in region i which is enjoyed by workers in sector s. We allow for sector-specific utility from local public expenditures, incorporating that workers in higher-income sectors may also profit more from publicly available services, such as infrastructure.[12] $0 < \alpha < 1$ is the preference weight for local public services. $\chi \in [0, 1]$ governs the extent of rivalry of public goods consumption with $\chi = 0$ capturing the case of a pure local public good and $\chi = 1$ of full rivalry.

Workers have idiosyncratic preferences $\Psi^g_{i,u}(\omega)$ for living and working in region-sector pair $\{i, u\}$. These idiosyncratic preferences are assumed to be independently and identically distributed across workers, locations, and time according to a Fréchet distribution with shape parameter $\theta^g > 1$ and scale parameter 1. For high values of θ^g, there is low variance in the idiosyncratic draws, such that there is little heterogeneity in individual workplace choices when faced with similar fundamentals. Additionally, workers differ with regard to their utility, $\eta^g_{s|i,u}(\omega)$, from local amenities and the size of participation costs they incur when joining the labour force (see Section C.4 for details).

In equilibrium, workers use their whole after-tax real income for local final goods consumption, such that

$$C^g_{s,u'|i,u} = \beta^C_{u'} \frac{I^g_{s|i,u}}{P_{i,u'}}, \tag{1}$$

with shares $\beta^C_{u'}$ over the consumption of local final goods satisfying $\sum_{u' \in M} \beta^C_{u'} = 1$.

Substituting the equilibrium values from (1) in the utility function, we can write the indirect utility for a worker ω of type g working in sector s and living in region i as a function of the after-tax real income, local public goods and two idiosyncratic preference components $\{\eta^g_{s|i,u}(\omega), \Psi^g_{i,u}(\omega)\}$ varying across worker types, regions and sectors

[12] Workers take these public expenditures as given. Hence, we will explicitly model the provision of public goods in Section C.3. For now, we assume for tractability that all workers in market sectors $u \in M$ enjoy the same level of public goods provision.

$$V^g_{s|i,u}(\omega) = \eta^g_{s|i,u}(\omega)\left(\frac{R_{s|i,u}}{L^{\chi}_i}\right)^{\alpha}\left(\frac{I^g_{s|i,u}}{P_i}\right)^{1-\alpha}\Psi^g_{i,u}(\omega), \tag{2}$$

with $P_i = \prod_{u'=1}^{M}(P_{i,u'}/\beta^C_{u'})^{\beta^C_{u'}}$ the region-specific price index.

Extensive Labour Supply. Via choosing their labour supply, workers maximize utility, subject to their budget constraint. However, workers with high income, high idiosyncratic preference for the home market or dis-utility from market work may not participate in the labour market. To micro-found extensive margin responses in labour supply, we introduce non-convexities in private and public goods consumption, as well as costs of market employment. We show below how these non-convexities have implications for the optimal design of fiscal policies.

At this point, a few comments about the exact timing of individual labour supply decisions are in order. First, all employed workers optimally choose any of the $J * M$ heterogeneous pairs as a place and market sector to work after receiving the idiosyncratic preference draws from a Fréchet distribution. Then, all employed workers jointly and simultaneously choose to move to the local labour market and sector that maximizes their expected utility. Afterwards, in a second stage, all workers L^g decide to remain in the market sector $u \in M$ or join the home market sector h given their individual preferences for the home market sector, as detailed below. Hence, workers decide about their extensive labour supply after their initial workplace decision. Going backwards, we derive first the extensive labour supply decisions of individual workers, conditional on their optimal choice of region $i \in J$ and market sector $u \in M$. Afterwards, we endogenize workers' spatial sorting and sectoral decisions in the first stage.

We now consider workers' extensive labour supply decision in the second stage, where they either join the home market sector h or remain in the labour force and market sector u.[13] We model the utility from consumption as potentially labour-market-status-dependent and account for the possibility that there might be a further deviation from pure public goods. Firstly, workers face a budget constraint, determined by their wage income $w^g_{s|i,u}$, that is taxed at local rate $\mathcal{T}_i$, such that

$$I^g_{s|i,u} = (1-\mathcal{T}_i)\, w^g_{s|i,u}. \tag{3}$$

Workers in the home market sector h receive only a fraction $1-\rho^g_{h,C}$ of the wage income in region i and market sector u as non-employment compensation.[14]

Moreover, each worker derives utility from public expenditures that not only depend

[13] Note that this implies that we only consider workers with an idiosyncratic preference draw $\Psi^g_{i,u}(\omega)$ for living and working in region-sector pair $\{i,u\}$ and condition on workers' previous region-sector choices {i,u}.

[14] The assumption of non-employment compensation as a constant elasticity function of wage income is similar to Notowidigdo (2020), where $1-\rho^g_{h,C}$ is the elasticity of non-employment income with respect to market wages.

on the amount of publicly provided goods and the number of other individuals consuming them, but also on their labour market status. In particular, non-employed workers may use fewer public goods, such as child care and infrastructure, than employed workers. Intuitively, non-employed workers impose a lower congestion force on public goods since they do not commute to work regularly (Guglielminetti et al., 2022) or are more likely to privately care for their young children (Brown and Herbst, 2022).

In sum, the following functional forms represent workers' incentive constraints:

$$w^g_{s|i,u} = \begin{cases} \left(w^g_{u|i,u}\right)^{1-\rho^g_{h,C}} & \text{if } s = h \\ w^g_{u|i,u} & \text{if } s = u \in M \end{cases} \quad \text{and} \quad R_{s|i,u} = \begin{cases} \left(R_{u|i,u}\right)^{1-\rho^g_{h,R}} & \text{if } s = h \\ R_{u|i,u} & \text{if } s = u \in M, \end{cases}$$

with $\{\rho^g_{h,C}, \rho^g_{h,R}\} \in [0,1]$.[15] Finally, the overall idiosyncratic preference component is given as:

$$\eta^g_{s|i,u}(\omega) = \begin{cases} \bar{A}^g_i \exp\left[\bar{B}^g_{h|i,u}\right] \varphi(\omega) & \text{if } s = h \\ \bar{A}^g_i \exp\left[-\mu^g_{u|i,u}\right] & \text{if } s = u \in M. \end{cases} \tag{4}$$

It contains a fundamental amenity term $\bar{A}^g_i$ common to all workers, which includes natural characteristics, like the weather, clean air, and water. Moreover, conditional on labour market participation, workers face participation costs $\exp\left[-\mu^g_{u|i,u}\right] \leq 1$ from joining either of the markets sectors $u \in M$.

Besides the differences in participation costs (and private as well as public consumption) one additional difference between market workers and home market workers comes from an additional preference shifter $\exp\left[\bar{B}^g_{h|i,u}\right] \varphi(\omega) \geq 1$.[16] This additional term follows the idea that there are costs of market employment (Cogan, 1981; Blundell and Shephard, 2012; Kleven and Kreiner, 2006), or workers dislike to work (Fajgelbaum et al., 2019; Chauvin, 2018). It generates another source of non-convexity, as it only takes values greater than one when workers join the home market sector h.

The home-market-specific preference shifter consists of an exogenous component $\exp\left[\bar{B}^g_{h|i,u}\right]$ and an idiosyncratic component $\varphi(\omega) > 1$, which allows accounting for heterogeneous extensive labour supply decisions inside each $\{i,u\}$-cell. We assume that the individual-specific preference draws φ come from a Pareto distribution with a worker-type-specific shape parameter $\epsilon^g > 1$:

$$G^g(\varphi) = 1 - \varphi^{-\epsilon^g}. \tag{5}$$

[15] Typically, we would expect $\rho_{h,C} > \rho_{h,R}$, such that the utility loss for non-employed workers from private good consumption is more significant than from public good consumption. In this sense, this assumption captures preference heterogeneity across workers with different labour market status. Note that this implies that non-employed workers' preferences are more geared towards public services. However, we do not impose any additional parameter restrictions on the value of $\{\rho^g_{h,C}, \rho^g_{h,R}\}$, but estimate their values in an empirical approach outlined in section D.

[16] To account for the fact that workers of different types have varying preferences for regions (Ahlfeldt et al., 2020) and sectors (Wiswall and Zafar (2018)), we allow idiosyncratic preferences and the participation costs from joining either of the markets sectors to differ by worker group.

Note that the shape parameters ϵ^g govern the heterogeneity of group-specific home market preferences: the larger ϵ^g, the larger the probability of receiving a draw below any given φ (less worker heterogeneity).

Workers join the home market sector h as long as achievable indirect utility exceeds indirect utility in the chosen market sector u. Comparing indirect utility in the home market h and the market sector u there exists a unique region-sector-specific cut-off level for individual home-market-preference shocks $\tilde{\varphi}^g_{s|i,u}$ above which workers join the home market sector:

$$\tilde{\varphi}^g_{s|i,u} = \left(\frac{1}{\mathcal{B}^g_{s|i,u}}\right)\left(\left[w^g_{u|i,u}\right]^{\rho^g_{h,C}}\right)^{1-\alpha}\left(\left[R_{s|i,u}\right]^{\rho^g_{h,R}}\right)^{\alpha}. \tag{6}$$

The parameter $\mathcal{B}^g_{s|i,u} \equiv \exp\left[\bar{B}^g_{h|i,u} + \mu^g_{u|i,u}\right] > 1$ captures the cost in terms of utility units for workers who join the labour force.[17] Intuitively, the cut-off increases with the difference between private and public consumption of market workers relative to non-employed workers. The preference components $\{\bar{B}^g_{h|i,u}, \mu^g_{u|i,u}\}$ further magnify this trade-off between market and home market work.

Using the properties of the Pareto distribution, the number of workers joining the home market sector h in region i, who initially selected the market sector u, is given by

$$L^g_{h|i,u} = \xi^g_{h|i,u} L^g_{i,u} = \left[\left(\frac{1}{\mathcal{B}^g_{s|i,u}}\right)\left(\left[w^g_{u|i,u}\right]^{\rho^g_{h,C}}\right)^{1-\alpha}\left(\left[R_{s|i,u}\right]^{\rho^g_{h,R}}\right)^{\alpha}\right]^{-\epsilon^g} L^g_{i,u}, \tag{7}$$

where $\xi^g_{h|i,u} \equiv L^g_{h|i,u}/L^g_{i,u}$ denotes the share of workers in the home market sector h in region i that joined the market sector u in the first stage. The total number of non-employed workers of group g in region i is then simply $L^g_{i,h} = \sum_{u \in M} L^g_{h|i,u}$. Several components affect local extensive labour supply decisions: firstly, higher after-tax income relative to non-employment transfers induces workers to join the market sectors since it increases the opportunity cost of selecting the home market (the "income effect"). This effect, however, declines if workers dislike to work (high $\bar{B}^g_{h|i,u}$) or joining the labour force in sector u is costly (large $\mu^g_{u|i,u}$).

Further, we allow local expenditures to affect local employment via so-called "fiscal multipliers" $\rho^g_{h,R}$: higher public expenditures shift up the cut-off level (6) and thereby push workers into the labour force. For example, higher public expenditures may induce workers to take up market employment if it decreases commuting costs via infrastructure investments (Duranton and Turner, 2012; Gibbons et al., 2019) or improves the quantity and quality of public childcare and after-school programs (Baker et al., 2008; Cornelissen

[17] These costs of market employment generate non-convexities of labour supply (Cha and Weeden, 2014; Cubas et al., 2019). They may be of financial nature (e.g., expenditures for child care and public transport), or they may correspond to time costs (e.g., commuting time (Le Barbanchon et al., 2021) or the possibility of working from home (Dingel and Neiman, 2020)), preferences for flexible hours (Erosa et al., 2022; Wasserman, 2022), as well as to emotional costs arising from the additional burden and stress of preserving a career (see also Kleven and Kreiner (2006)).

et al., 2018). The shape parameter of the Pareto distribution ϵ^g governs the overall size of group-specific labour supply adjustments following shifts in the cut-off $\tilde{\varphi}^g_{s|i,u}$ as defined in (6).

C.2 Production

Firms in all market sectors produce many varieties of intermediate goods. The production technology of intermediate goods requires labour and land and structures as well as materials, which consist of inputs from all market sectors (Caliendo et al., 2018, 2019). Furthermore, intermediate good producers vary by their productive efficiency, which we denote by $z_{i,u}$ for each variety.

Intermediate Goods Producers. The output of a producer of an intermediate variety with efficiency $z_{i,u}$ is given by

$$y_{i,u}\left(z_{i,u}\right) = z_{i,u}\left[\left(h_{i,u}\left(z_{i,u}\right)\right)^{\kappa_{i,u}}\left(l_{i,u}\left(z_{i,u}\right)\right)^{1-\kappa_{i,u}}\right]^{\delta_{i,u}}\prod_{u'\in M}\left[M_{i,uu'}\left(z_{i,u}\right)\right]^{\delta_{i,uu'}}, \tag{8}$$

where $h_{i,u}(.)$ and $l_{i,u}(.)$ are the demand for land and structures and labour respectively.[18] $M_{i,uu'}(.)$ denotes material inputs from sector u', demanded by a firm located in region i and operating in sector u under efficiency $z_{i,u}$ to produce $y_{i,u}$ units of an intermediate variety. $\delta_{i,uu'}$ is the share of materials from market sector u' in the production of market sector u in region i, while $\delta_{i,u}$ denotes the share of total value added in gross output. We assume constant returns to scale technology, such that $\sum_{u\in S}\delta_{i,uu'} = 1-\delta_{i,u}$. Finally, the parameter $\kappa_{i,u}$ denotes the share of land and structures in value added.

We assume that the different labour types are imperfectly substitutable inputs to the production function

$$l_{i,u}\left(z_{i,u}\right) = \left[\sum_{g\in G}\left(T^g_{i,u}L^g_{u|i,u}\left(z_{i,u}\right)\right)^{\frac{\sigma^g-1}{\sigma^g}}\right]^{\frac{\sigma^g}{\sigma^g-1}}, \tag{9}$$

where $L^g_{u|i,u}$ denotes the number of workers of type g employed in region-sector pair $\{i,u\}$ and $\sigma^g > 1$ denotes the elasticity of substitution between workers of different types in the production of varieties. Workers' productivity in region i and market sector u is determined by their group-specific human capital $T^g_{i,u}$. We allow for the possibility that extensive labour supply may cause positive productivity externalities ("agglomeration externalities"). Fundamental productivity, therefore, consists of an exogenous component

[18] The presence of a fixed factor (it could also be capital if not land and structures) leads to a downward-sloping labour demand curve in each location and acts as a congestion force on the model (Redding and Rossi-Hansberg, 2017). Note that fundamental productivity shifts local value and not total production in this set-up. This ensures that any productivity increases translate into higher gross output in real terms.

$\bar{T}^g_{i,u}$, which gets endogenously shifted by the size of the local labour force, such that:

$$T^g_{i,u} = \bar{T}^g_{i,u} \left(\sum_{u \in M} \sum_{g \in G} L^g_{u|i,u} \right)^{\zeta^g},$$

where the productivity spillover has a constant group-specific elasticity $\zeta^g > 0$.[19] Denoting as r_i the rental price of land and structures in region i we obtain the following formulation for the cost of inputs $\lambda_{i,u}$ in region-sector pair {i,u} (see Appendix I.2 for details):

$$\lambda_{i,u} = D_{i,u} \left(r_i^{\kappa_{i,u}} \left[\sum_{g \in G} \left(\frac{T^g_{i,u}}{w^g_{u|i,u}} \right)^{\sigma^g - 1} \right]^{\frac{1-\kappa_{i,u}}{1-\sigma^g}} \right)^{\delta_{i,u}} \prod_{u' \in M} \left[P_{i,u'} \right]^{\delta_{i,uu'}}, \tag{10}$$

with the constant $D_{i,u} \equiv \left(\delta_{i,u} \left(\kappa_{i,u} \right)^{\kappa_{i,u}} \left(1 - \kappa_{i,u} \right)^{(1-\kappa_{i,u})} \right)^{-\delta_{i,u}} \prod_{u \in S} \left(\delta_{i,uu'} \right)^{-\delta_{i,uu'}}$.

Trade costs are represented by $\tau_{ij,u}$ and are of the 'iceberg' type. One unit of any variety of intermediate good u shipped from region j to i requires producing $\tau_{ij,u} \geq 1$ units in region j. If a good is non-tradable, then $\tau_{ij,u} = \infty$. Given constant returns to scale and competitive intermediate goods markets, a firm produces only positive amounts of a variety as long as its price equals its unit production cost, $\lambda_{i,u}/z_{i,u}$.

We assume that across all varieties, market sectors, and regions the idiosyncratic productivity levels $z_{i,u}$ are independently drawn from a Fréchet distribution such that the joint cumulative distribution function is given by

$$\phi_u \left(z_{i,u} ..., z_{J,u} \right) = \exp \left\{ - \sum_{i \in J} \left(z_{i,u} \right)^{-\nu_u} \right\}, \tag{11}$$

where we normalize the scale parameter to unity, and the market-specific shape parameters $\nu_u > 1$ govern the variance of efficiency draws. A larger ν_u implies less variability across varieties and regions.

Final Good Producers. Final goods producers purchase varieties of intermediate goods from the location j in which the acquisition cost, including trade costs, is the least. Intermediate goods demanded from sector u and all regions are combined into a local CES bundle (final good). Local final goods, in turn, are used as materials for the production of intermediate varieties and final consumption and as an input into the production of local public goods. There are no fixed costs or barriers to entry in the production of intermediate and final goods, such that competitive behaviour implies zero profits at all times. Given the properties of the Fréchet distribution and the assumption of a CES aggregate

[19] Similarly to Fajgelbaum and Gaubert (2020) the productivity spillovers may also depend on the distribution of worker types. For now, we abstract from these restrictions. We assume that spillovers have the same productivity augmenting effect across all market sectors.

final good, we derive the price of the aggregate good in market sector u and region i as

$$P_{i,u} = \Gamma\left(\gamma_u\right)^{\frac{1}{1-\sigma}} \left[\sum_{j\in J} \left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}\right]^{-\frac{1}{\nu_u}}, \tag{12}$$

where $\gamma_u \equiv \frac{\nu_u+1-\sigma}{\nu_u}$ and $\Gamma(.)$ denotes the Gamma function. The functional assumptions on the distribution of efficiencies across regions finally allow deriving the share of total expenditures in region-sector pair $\{i,u\}$ that accrues to sector-u-goods from region j as

$$\pi_{ij,u} = \frac{X_{ij,u}}{X_{i,u}} = \frac{\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}}{\sum_{n\in J}\left(\lambda_{n,u}\tau_{in,u}\right)^{-\nu_u}}, \tag{13}$$

with $X_{ij,u}$ the expenditure in region i on sector u goods produced in region j and $X_{i,u} = Y_{i,u}P_{i,u}$ are total expenditures on goods from sector u in region i.[20] The cheaper the cost of production in region-sector pair $\{j,u\}$ or the smaller bilateral trade costs between region j and i, the more producers in region i purchase varieties from region j. Bilateral trade shares finally decrease in the denominator of equation (13), the destination-specific 'multilateral resistance' term.

Local final goods are used either for private consumption, as materials or as an input for the local final public good, such that

$$P_{i,u'}Y_{i,u'} = \beta^C_{u'}C_i + \beta^R_{u'}E_i + \sum_{u\in M} M_{i,u'u}P_{i,u}, \tag{14}$$

where $X_{i,u'} \equiv P_{i,u'}Y_{i,u'}$ denotes the total value of final goods production. C_i is the total value of private consumption, $E_i = R_iP^R_i$ is the total expenditure of local governments on final goods, and P^R_i is the optimal local price level of local governments, which differs from worker's local price level as long sectoral expenditure shares differ for private and public consumption.[21]

C.3 Ownership of Fixed Factors, Governments and Spatial Transfers

In describing the fiscal redistribution scheme and the public sector discussed in Section B.1, we closely follow Henkel et al. (2021). The redistribution scheme is similar to the setting in Fajgelbaum and Gaubert (2020) where spatial policies tax and transfer income across locations and more broadly to place-based policies (Kline and Moretti, 2014).

Local governments run balanced budgets and, in the absence of spatial transfers, could only use local tax revenues and rental income to provide public services and finance non-employment compensation. However, spatial transfers set by the Federal government alter local governments' budgets. The local government uses its available fiscal budget to

[20] See section (I.2) in the Online Appendix for derivations.

[21] To quantify our model, we calibrate the expenditure shares of local governments β^R_u to fit the observable share of housing in *private* consumption. See identification step 5 in online appendix J.2 for details.

purchase local final goods from all sectors at local prices as input for the provision of a local public good R_i, produced according to a Cobb-Douglas production function under no additional costs with shares $\beta^R_{u'}$ and where $\sum_{u' \in M} \beta^R_{u'} = 1$. In determining the ownership of fixed factors, we assume that local governments own the land and structures in all regions and rent them to firms at local rates. The local rents enter a national portfolio to finance non-employed compensation in all regions. The remaining share gets redistributed back to local governments according to the share $\iota_i \geq 0$, with $\sum_{i \in J} \iota_i = 1$.[22]

Further, local governments tax total labour income at the local rate $\mathcal{T}_i$. The Federal government collects local tax revenues and uses spatial transfers to redistribute them back to local governments according to the transfer rate ρ_i, which is proportional to the local labour income (and is negative for donor regions and positive for recipients).

Given local tax revenues, spatial transfers, and receipts from the national portfolio, the fiscal budget of local governments reads

$$E_i = (\mathcal{T}_i + \rho_i) \left(\sum_{s \in h,u} \sum_{u \in M} \sum_{g \in G} w^g_{s|i,u} L^g_{s|i,u} \right) + \iota_i \mathcal{K}, \tag{15}$$

where $\sum_{u \in M} \mathcal{H}_{i,u} r_i$ denotes the total of collected local rents across all market sectors in region i and $\mathcal{K} = \left(\sum_{j \in J} \sum_{u \in M} \left(\mathcal{H}_{j,u} r_j - \sum_{g \in G} \left(w^g_{u|j,u} \right)^{1-\rho^g_{h,C}} \xi^g_{h|j,u} L^g_{j,u} \right) \right)$ denotes the national portfolio of local rents, net of non-employment compensation.

This setting creates spatial variation in local public expenditures affected by imbalances between the tax revenues and local rents collected by local governments and the transfers from the national portfolios of local labour income and local rents. Any variations in local wages and rental rates of land and structures affect the spatial transfers and receipts from the nationwide portfolio, resulting in changes in local public expenditures.

C.4 Spatial Sorting, and Sectoral Selection

So far, we have fixed the number of workers in all region-sector pairs $\{i, u\}$. Now, we endogenize the workers' spatial sorting and sectoral selection decisions. As workers form expectations about their probability of becoming non-employed, they use expected indirect utility to make their initial spatial sorting and sectoral selection decisions.

Combining equations (2) and (7) and using the properties of the Pareto distribution,

[22] As discussed in Redding and Rossi-Hansberg (2017), there are different methods of incorporating land rents into the analysis. Assuming absentee landlords, as it is standard in the urban economics literature, would not allow us to capture full general equilibrium effects. To circumvent this problem, we introduce a nationwide portfolio that collects the local rents of the economy to finance non-employment compensation, and local governments retain shares of the remainder of this portfolio. Note that as long as local governments hold shares in this portfolio of the fixed factor, the competitive equilibrium will be inefficient. In this case, workers do not internalize the effect of their spatial sorting decisions on local consumption possibilities through local fiscal budgets. See Fajgelbaum and Gaubert (2020) for a discussion on how the ownership of fixed factors determines whether optimal spatial policies should redistribute toward or away from high-wage regions.

expected indirect utility of workers is finally given as:

$$\bar{V}^g_{i,u}(\omega) = \Psi^g_{i,u}(\omega)\,\bar{V}^g_{i,u} = \Psi^g_{i,u}(\omega)\sum_{s\in h,u} V^g_{s|i,u}\xi^g_{s|i,u} \\ = \Psi^g_{i,u}(\omega)\,V^g_{u|i,u}\left(1+\frac{\xi^g_{h|i,u}}{\epsilon^g-1}\right) \tag{16}$$

Under the definition of indirect utility of market-employed workers defined in (2), expected utility increases in private and public good consumption as well as local amenities relative to region-sector-specific participation costs. In the presence of rivalry in public goods consumption (i.e. $\chi > 0$), the "fiscal multiplier" effect imposes another negative externality on local worker welfare. The intuition works as follows: Given the amount of local public expenditures, a larger share of employed workers in region i increases the congestion of per capita public services as long as non-employed workers consume public goods less extensively. For example, non-employed workers may not commute to work or choose to privately care for their young children.[23]

All else equal, workers, therefore, prefer being surrounded by non-employed workers since they allow for larger per capita public good consumption. When making their own extensive labour decisions, individual workers, nonetheless, do not take into account the externalities they impose on all other workers. The size of externalities is governed by the heterogeneity in individual preference draws: the larger is the variance in home-market preferences (small ϵ^g), the smaller the labour supply elasticity, which implies smaller labour force adjustments following changes in public spending or local income. As result, congestion of public services increases by a smaller amount for the same change in income or public expenditure when worker heterogeneity is large.

All workers then choose the region-sector pair $\{i, u\}$ that maximizes their expected utility $\bar{V}^g_{i,u}(\omega)$ in the first stage. Using the fact that the maximum of a Fréchet-distributed random variable is itself Fréchet distributed, we derive the expected indirect utility of type-g workers in the market sectors as

$$\mathcal{V}^g = \Gamma\left(\frac{\theta^g-1}{\theta^g}\right)\left(\sum_{u\in M}\sum_{i\in J}\left[\bar{V}^g_{i,u}\right]^{\theta^g}\right)^{\frac{1}{\theta^g}}, \tag{17}$$

where perfect worker mobility ensures that expected utility is equalized everywhere in the economy. Given the assumptions on the functional form of the preference shock distribution and the expected utility defined in equation (16), we then get closed-form solutions for labour supply in spatial equilibrium. The number of workers of type g choosing region

[23] Apart from increasing the congestion in local public goods consumption, employed workers also impose two additional, positive externalities on local economies: when introducing the production side, we allow for agglomeration economies of employed workers in Section C.2 and endogenous fiscal budgets of local governments. Employed workers, hereby, contribute more to local tax revenues as long as tax payments are proportionate to nominal income.

i and market sector u is given by:[24]

$$L_{i,u}^{g} = \frac{\left(\bar{V}_{i,u}^{g}\right)^{\theta^g}}{\sum_{u \in M} \sum_{i \in J} \left(\bar{V}_{i,u}^{g}\right)^{\theta^g}} L^g. \tag{18}$$

The attractiveness of region-sector pairs increases in the preference for working and living in region i and market sector u, local public goods consumption, and after-tax real income, which in turn is a function of average wages, taxes, and regional price levels. Additionally, the expected utility of region increases in the share of locally non-employed workers: non-employed individuals congest the local good good by a smaller amount, which allows for a larger per capita public good consumption. The parameter θ^g controls the sensitivity of a region-sector pair's employment to changes in its relative expected after-tax per-capita real income, type-specific preferences, and the reaction in extensive labour supply of households to local public goods provision.

C.5 General Equilibrium

Given vectors of exogenous region-sector-specific characteristics $\{\bar{T}_{i,u}, \bar{B}_{h|i,u}, \mu_{u|i,u}^{g}, \bar{A}_{i}^{g}, \mathcal{H}_{j,u}\}$, the total number of workers L^g, spatial policies $\{\mathcal{T}_i, \rho_i, \iota_i\}$, and model parameters $\{\alpha, \beta_u^C, \beta_u^R, \theta^g, \epsilon^g, \delta_{i,s}, \delta_{i,su}, \kappa_{i,s}, \rho_{h,C}^{g}, \rho_{h,R}^{g} \sigma_g, \sigma, \tau_{ij,s}, \nu_s, \chi\}$, a general equilibrium of this economy is defined as a vector of endogenous objects $\{E_i, L_{h|i,u}^{g}, L_{i,u}^{g}, w_{s|i,u}^{g}, r_i, P_i s\}$. These components of the equilibrium vector are determined by 12 sets of equations. In a spatial equilibrium, the intermediate and final goods markets clear, labour markets clear, markets for land and structures as well as materials clear in all region-sector pairs $\{i, u\}$, and the local government budget constraint holds.

In Online Appendix I.3, we provide a complete summary of all model market clearing conditions and of all 12 sets of equations, which determine the spatial equilibrium in our theoretical framework. In developing our model above, we have followed the quantitative spatial economics literature with nonconvexities running through spatial spillovers (in production or amenities) as surveyed in Redding and Rossi-Hansberg (2017). At this stage, we underscore the added features in our framework relative to the literature. As standard in quantitative spatial models, the location decisions of workers drive both the marginal product of labour and the marginal utility of consumption. However, our framework features additional sources of nonconvexities running through the opportunity costs of extensive labour supply decisions. It features an additional congestion force, as the marginal utility of consumption (in local public expenditures and non-employment compensation) depends on local workers' labour market status. To be clear, the welfare of workers changes with the number of locally employed workers through $w_{s|i,u}^{g}$, $R_{s|i,u}$, and fundamental productivity features increasing returns to scale to the number of employed

[24] The probabilities in (18) follow a similar form as the choice probabilities in discrete choice models under Generalized Extreme Value (GEV) distributions (Mcfadden, 1974). See section I.1 in the Online Appendix for details.

workers through $\bar{T}^g_{i,u}\left(\sum_{u\in M}\sum_{g\in G}L^g_{u|i,u}\right)^{\zeta^g}$. In this framework, competitive equilibria may be socially inefficient: workers do not internalize the impact of their location decisions on local public goods provision R_i and efficiency through $T_{i,u}$. Moreover, they do not internalize the effect of their extensive labour supply decisions on consumption through $w^g_{s|i,u}, R_{s|i,u}$.

D Data and Quantification

So far, we have estimated the impact of local government spending on labour force participation rates in Section B. Now, we discuss how we obtain the rest of the model parameters and identify model-implied variables from the data.

To take the model to the data, we use the fiscal re-distribution scheme, described in Section B.1, across 141 local labour markets in Germany in 2008. Following our empirical estimates in Section B.2, we identify worker groups g with gender to study the spatial distribution and extensive labour supply decisions of female and male workers. Apart from the home market sector, we construct six market sectors, from which four include tradable and two non-tradable goods (Construction and non-tradeable services).

For the model quantification, we require data on employment, non-employment, wages by worker group, tax revenues and spatial transfers by region. Further, we need bilateral trade flows, gross output, input-output linkages, and value-added by region-sector pair. Section J.1 in the Online Appendix describes the data sources we use to quantify the model and presents the identification steps to derive the model-implied variables from the data. Table 1 lists the parameters used in our model quantification and the sources used to calibrate or estimate them.

D.1 Utility and Production Function Parameters

We use the Ahlfeldt et al. (2020) average estimates of the gender-specific productivity spillovers for Germany ($\zeta^M = 0.018; \zeta^F = 0.032$) and set the elasticity of substitution between male and female workers in the production of differentiated varieties at $\sigma^g = 2.5$. Both are in the middle of other available estimates (Combes and Gobillon, 2015; Olivetti and Petrongolo, 2014).[25]

For the elasticity of substitution of varieties across regions, we borrow estimates from the standard gravity literature (Head and Mayer, 2014) and set $\sigma = 5$. Further, we follow the literature and parameterize bilateral trade costs as a constant elasticity function of distance for all tradable sectors, while for the non-tradable sectors we treat trade costs as infinite. Following equation (13), we estimate the combined sector-specific parameter $-\nu_s\zeta_s$ using standard gravity regressions based on bilateral trade flows recovered from the

[25] The literature on agglomeration economies (Rosenthal and Strange, 2004) documents values of agglomeration spillovers ranging from 0.01 to 0.06. Depending on the occupation of workers Bhalotra and Fernández (2018) estimate the elasticity of substitution between men and women to be between 1.2 and 2.7 in Mexico, whereas Acemoglu et al. (2004) obtain a slightly larger estimate of 3.

Forecast of Nationwide Transport Relations in Germany 2030 (Schubert et al. (2014)). We find that the estimated distance coefficients range between -1.43 and -2.14. They are highly statistically significant and firmly in line with available estimates from the gravity literature (Head and Mayer, 2014). We then parameterize trade costs according to ($\tau_{ij,s} = dist_{ij}^{\zeta_s}$), while, as in Rossi-Hansberg et al. (2019), setting trade elasticities to $\nu_s = 10$ for all sectors, which is well within the range of values considered by Head and Mayer (2014).

The administrative labour market data on compensation of employees from the IAB allows us to calculate wage compensation per region and sector. We calibrate the labour share in production, $1 - \kappa_{i,s}$, to match region-sector specific labour payments relative to value added. We calibrate the share of value-added $\delta_{i,s}$ to match their existing data counterparts on gross output from EU KLEMS (Stehrer et al. (2018)) and gross value-added from the regional economic accounts provided by the Statistical Office of the European Union (Eurostat). To determine the share of sector u goods used in sector s and region i, $\delta_{i,su}$, we rely on national input-output shares δ_{su} from the World Input-Output Tables (WIOD, see Timmer et al. (2015)), noticing that $\delta_{i,su} = (1 - \delta_{i,s})\delta_{su}$.

We assume perfect rivalry for local public goods and set $\chi = 1$ for our main analysis, but we also study the other extreme of pure public goods ($\chi = 0$) in the robustness checks. Assuming $\chi = 1$, Fajgelbaum et al. (2019) obtain a value of $\alpha = 0.2$ for the preference weight for local public services and $\theta^g = 1.73$ for the Fréchet shape parameter, which we also borrow for the quantification of our model. Given the Cobb-Douglas utility structure, α represents the expenditure share on public goods, which should equal the average local tax rate with a balanced overall budget. Local public finance data for Germany also suggests a similar value, which justifies our chosen value. We set the shape parameter of the Pareto distribution $\epsilon^g = 5$, which governs the overall size of group-specific labour supply adjustments, for male and female workers to match the share of non-employment compensation to market wage of 60% using the average national wage income in Germany. We follow the recommendation in (Chetty et al., 2011) to calibrate our model to match micro estimates identified from quasi-experimental studies of extensive labour supply elasticities and set $\rho_{h,C}^g = (0.25/\epsilon^g)/(1 - \alpha)$.

Moreover, local fiscal budgets pin down local shares ι_i in the national portfolio. Our main data sources are official tax data provided by the German Statistical Office and the Federal Statistical Office (see Statistisches Bundesamt (2021b); Statistisches Bundesamt (2021a); Statistische Ämter des Bundes und der Länder (2021)). Using this combined data on local public finance, we allocate tax revenues (federal, state, and local municipalities) to the local level and calculate the corresponding fiscal transfers (within and between the Federal States). We follow Henkel et al. (2021) in computing local tax revenues and net fiscal transfers and relate them to local labour income to obtain tax t_i and transfer rates ρ_i per region.

Using this calibration, there exist unique values of expenditure shares $\{\beta_s, \beta_s^R\}$ which ensure that markets clear for all sectors in the aggregate, given the regional tax and transfer rates. This allows us to derive model-consistent expenditures of all regions that rationalize goods market-clearing (see identification steps 1 - 5 in online appendix J.2 for further details and derivations). We then estimate the regional shares in the national portfolio, ι_i, by minimizing the distance between the fiscal revenue share in the data ($\Upsilon_{i,Data}$) and the fiscal revenue shares consistent with our model ($\Upsilon_{Model} = E_i / \sum_{i \in J} E_i$).

The cost-minimizing behaviour of producers ensures that bilateral trade flows decrease in the size of unit production costs. The fact that model-consistent trade flows follow a gravity equation (13), therefore, allows us to identify the unit costs $\lambda_{j,u}$ from model-consistent expenditures $X_{j,s}$ in all origin regions $j \in J$ demanded by workers in region i. In all tradable sectors, these directly translate into regional price levels. For all non-tradable sectors, we rely on regional price level indices by sector, which we describe in more detail in data appendix J.1.

D.2 Elasticity of extensive labour supply

With the values for the Cobb-Douglas share of local public goods and the shape parameter of the preference distribution α, ϵ^g, we recover the structural parameters $(\rho^F_{h,R}, \rho^M_{h,R})$ from the estimated reduced-form elasticities in Section B.2.2, which is equivalent to the gender-specific elasticity of worker's extensive labour supply decisions with respect to public good provision.

We start with the observation that the Census shock for treated regions was three percentage points larger compared to the control regions.[26] At the same time, each additional percentage point increase in the Census shock led to 0.956% higher per capita revenue for local jurisdictions, as shown in Table 4. The average treated region, therefore, lost approximately 3% of its total fiscal capacity following the Census shock. Combining this information with the estimate for the average treatment effect in Table 2 the elasticities of public good provision to local employment are given by $\rho^F_{h,R} = (0.0575/5)/0.2 = 0.0575$ and $\rho^M_{h,R} = 0.0445$.

D.3 Local Productivity

We use our derived local price levels for the tradeable sector from the model together with the regional price indices for all non-tradable sectors, as well as data on local land rent indices, provided by the Federal Statistical Office (Statistische Ämter des Bundes und der Länder, 2021), to identify gender-specific productivity levels as the residual to unit costs. Intuitively, we fit gender-specific productivity levels to trade flows and goods expenditures (controlling for differences in income and expenditure on materials and land and structures) in an approach that is directly motivated by our spatial model.[27]

[26] See Table 6 for a summary of the Census shock across treated and non-treated regions.
[27] See identification steps 6 - 9 in online appendix J.2 for further details and derivations.

Table 1: Parameter Values

Parameter	Description	Approach	Source
	Production		
$\zeta^g = \{0.018; 0.032\}$	Productivity spillovers	Set	Ahlfeldt et al. (2020)
$\sigma^g = 2.5$	Elast. of substitution btw males and females	Set	Olivetti and Petrongolo (2014)
$\sigma = 5$	Elast. of substitution of varieties	Set	Head and Mayer (2014)
$\nu_s = 10$	Trade elasticity	Set	Head and Mayer (2014)
$\tau_{ij,s} = \{1, ..., 1.03\}$	Trade cost	Est.	Trade flows from Schubert et al. (2014)
$1 - \kappa_i = \{0.05, ..., 0.93\}$	Labour share in production	Cal.	Wage income/ Value added
$\delta_{i,s} = \{0.30, ..., 0.65\}$	Share of value added	Cal.	Value added / Gross output
$\delta_{i,su} = \{0, ..., 0.32\}$	Share of material inputs	Cal.	Input-Output Tables
$\beta_s = \beta_s^R = \{0.001, ..., 0.42\}$	Expenditure share	Fit.	Equation (42)
	Preferences		
$\chi = \{0; 1\}$	Rivalry in public goods cons.	Set	Fajgelbaum et al. (2019); Henkel et al. (2021)
$\alpha = 0.2$	Cobb-Douglas preferences weight on public good	Set	Fajgelbaum et al. (2019); Henkel et al. (2021)
$\theta^g = 1.73$	Fréchet shape parameter	Set	Fajgelbaum et al. (2019)
$\epsilon^g = 5$	Pareto shape parameter	Cal.	$\text{Mean}\left(w^g_{u\|i,u}\right)^{(1-\rho^g_{h,C})} = 0.6 \times \text{Mean}\left(w^g_{u\|i,u}\right)$
	Extensive Labour Supply		
$1 - \rho^g_{h,C} = 0.938$	Non-employment comp./Wage income	Cal.	Chetty et al. (2011)
$1 - \rho^g_{h,R} = \{0.956; 0.943\}$	Non-employed public goods cons./Employed public goods cons.	Est.	Section B.2.2
	Government		
$\mathcal{T}_i = \{0.15, ..., 0.33\}$	Regional tax rate	Cal.	Tax revenues
$\rho_i = \{-0.11, ..., -0.27\}$	Transfer rate	Cal.	Transfer payments
$\iota_i = \{0, ..., 0.09\}$	Share of national portfolio	Est.	Fiscal budget shares

Notes: "Calibrated" means we fit the model to observable data outlined under "data". We identify parameter values following the estimation steps outlined in appendix J.2 and using the data sets under "source". "Fitted" parameters match the model-consistent equations outlined under "source".

D.4 Local Amenities and Participation Costs

We recover the overall amenities $\eta_{i,s}$ for all market sectors from equation (18) as the residual to observable labour supply by worker group, region, and sector after controlling for after-tax real income and public goods provision by the local government. To decompose the overall amenity term into a fundamental term common to all workers and region-sector-specific participation costs, we normalize overall amenities to a group-specific mean of 1 and take the log transformation of both sides of equation (4) such that

$$\ln \eta_{i,s} = \bar{A}_i^g + \varepsilon_{i,s}, \tag{19}$$

where the worker-group-region-specific fixed effect $\bar{A}_i^g$ captures the fundamental amenities in the model. The last term is the log of a stochastic error, which we assume to be orthogonal to fundamental amenity. We estimate (19) by simple OLS to purge out the fixed effects for each region. The participation costs are then simply given by $\mu_{i,s} = \ln \eta_{i,s} - \bar{A}_i^g$. Since we identify amenities only up-to-scale, we re-scale them to ensure that the participation costs are positive for all region-sector pairs.

E Counterfactual Analysis: Shocks to Fiscal Transfers

Using different counterfactual scenarios, we now highlight the role of public fiscal policy for local labour supply decisions and the spatial distribution of economic activity in general equilibrium.

Our case in point is a large-scale government investment program, which includes spatial transfers and serves as a prominent example of recent German place-based policies. The public policy was initiated in 2008 by the introduction of a child support bill, the so-called "Kinderförderungsgesetz" (KiföG). The primary goal of the investment program was to provide the legal right to a public childcare place for all children over the age of one in Germany until the end of 2013. From 2014 on, the program was extended to fund further investment projects that served to create additional childcare places.

By constructing our counterfactual, we exploit the fact that the German government passed another bill (called "Gesetz über Finanzhilfen des Bundes zum Ausbau der Tagesbetreuung für Kinder", KiföGFinG) that precisely regulated how to finance the massive investments in public childcare provision, and introduced a special asset fund dedicated towards childcare investments (the "Sondervermögen Kinderbetreuungsausbau"). This special fund provided 5.41 billion euros of financial aid for investments in daycare facilities and daycare for children under the age of three to the federal states and municipalities between 2008 and 2021.[28] The special fund was split among the States, depending on the number of children under the age of three. The single states then mostly distributed

[28] See "Kinderbetreuungsfinanzierungsgesetz vom 18. Dezember 2007 (BGBl. I S. 3022), das zuletzt durch Artikel 3 des Gesetzes vom 14. Juli 2020 (BGBl. I S. 1683) geändert worden ist". This bill was coupled with other infrastructure investments such that the whole investment sum used in the counterfactual amounts to more than 20 billion euros.

the funds among their municipalities and districts according to the same procedure. We focus on this public policy since (i) the local investments were mainly financed by intergovernmental transfers, whereas it was financed by a federal fund towards which all regions contributed, and (ii) the specificity of the underlying law allows determining the subsequent distribution of federal funds across the economy.[29] Hence, although the program was national in scope, we can exploit the circumstance that its impact on a given local labour market depended on the already existing number of local childcare places and the size of the female labour force. Lastly, with its potential on affecting (especially female) labour supply (Olivetti and Petrongolo, 2017), it gives additional support for our modelling choice with two distinct worker groups that are differently impacted by public expenditures.

We try to keep our counterfactual policy experiment simple, since we view it mainly as an illustrative example of a prominent place-based policy. We could apply our model framework to evaluate any government investment program that shifts public funds across jurisdictions or impacts fiscal policy at the local level. In future work, we want to calculate the optimal spatial policies that maximize aggregate welfare, which account for the fact that optimal transfers should depend on spatial mobility and the extensive labour supply decisions of workers.

Procedure of the Counterfactual Analysis. In the baseline version of our counterfactual analysis, we assume fixed values of all structural parameters and use inverted exogenous components of preference shifters, amenities, and human capital levels as in the initial equilibrium (that is, in the year 2008). We then assume that the childcare investment program is financed by a proportionate decrease in the national portfolio. Hereby, more populous regions also contribute more towards the financing of the program. The so-financed funds are subsequently allocated to the different regions according to a predetermined key, which is directly derived from the KiföGFinG depending on the number of children under the age of three.

The introduction of the policy changes the fiscal transfer scheme, which we use as starting point for our main counterfactual. Our algorithm subsequently solves for the new equilibrium values of wages, employment, and prices, which rationalize a spatial equilibrium with updated inter-regional transfers and local public good provision. The new (counterfactual) equilibrium values of real wages, employment gaps, and rents ensure that all goods and factor markets clear in the new equilibrium (see section K.1 in the Online Appendix for details).

Local Effects. The counterfactual changes in tax and transfer rates imply substantial fiscal re-distribution across space, particularly from urban and southern German regions

[29] In Germany, it is generally a daunting task to identify the flow of fiscal funds from federal to sub-federal jurisdictions that relate to specific spending programs since no publicly available data on public expenditure by program type exists (Buchheim and Watzinger, 2022).

to rural parts of Eastern Germany. As highlighted in Panel (a) of Figure 4, fiscal budgets increase by up to 1.4 per cent of local income in some rural Eastern German labour markets. Note that there is a clear tendency to redistribute funds from the largest metropolitan areas in West Germany (e.g., Hamburg, Frankfurt, or Munich) to the East. Fiscal revenue shocks directly affect the capacity of governments to supply local public goods, which in turn triggers workers to re-consider their initial residence and labour supply decisions.

Workers relocate to regions with larger public good provision, as highlighted in Panel (b) of Figure 4. As workers move into positively treated regions, they impose downwards pressure on local real wages. Panel (c) of Figure 4 highlights that workers in regions with more significant fiscal budget growth experienced larger real wage decreases. According to the canonical Rosen-Roback spatial equilibrium framework, these mobility, wage, and price adjustments will continue until the average utility of workers is again equalized across regions and occupational sectors in the new counterfactual equilibrium.

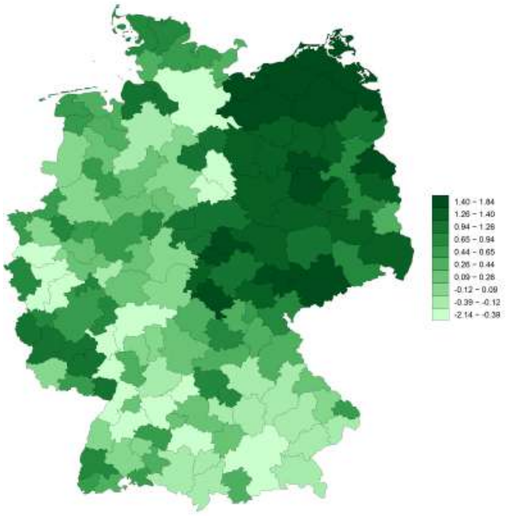
Our framework, however, extends this canonical framework by focusing on the role of extensive labour supply decisions as an additional channel of adjustment and showing how they change the quantitative and qualitative predictions of counterfactuals that redistribute funds across the economy. According to local labour supply equations (7) and (18) there are four channels through which the counterfactual shock affects individual labour supply. In the first instance, positive shocks to fiscal budgets pull infra-marginal workers into positively-treated parts of the economy. The mobility of workers across regions and sectors, furthermore, affects both the size of regional wages (Panel (b) of Figure 4) and the local composition of the workforce across occupational sectors and, in turn, the importance of region-sector-specific participation costs.

Additionally, positive shocks to fiscal capacities and local public good provision, increase the local labour force via the "fiscal multiplier channel". In the long run, worker mobility enhances this effect since migration inflows enlarge the size of the local labour force and, in turn, tax revenues, but simultaneously "congest" public good provision as long as public services are rivalrous. Since these effects work in opposing directions, predictions about the impact of the counterfactual on local labour force participation rates are a priori ambiguous. Panel (d) of Figure 4 suggests, however, suggests that the "fiscal multiplier" channel dominates and predicts an increase in labour force participation rates in Eastern Germany.

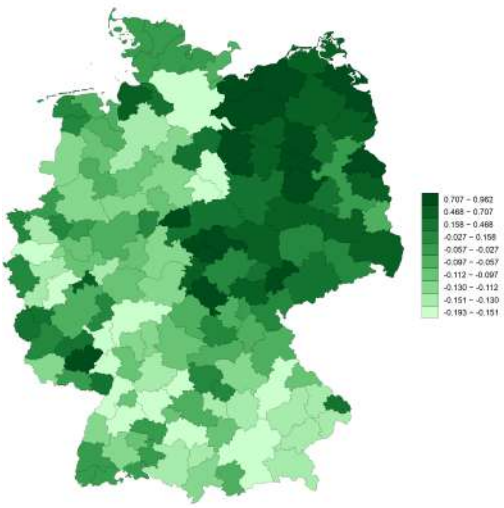
Aggregate Effects - Local Fiscal Multipliers. In columns (1) and (2) of Table 2 we highlight the aggregate effects of the counterfactual distribution of fiscal funds. In doing so, we distinguish between *donor* regions and *recipient* regions whose transfer rate increased following the policy intervention. Intuitively, *recipient* regions received more fiscal transfers from the federal investment fund than they initially contributed towards its set-up.

The childcare investment fund initially increases per capita capacities and public good provision in *recipient* regions. Thus, we observe sizeable worker flows, with *donor* regions

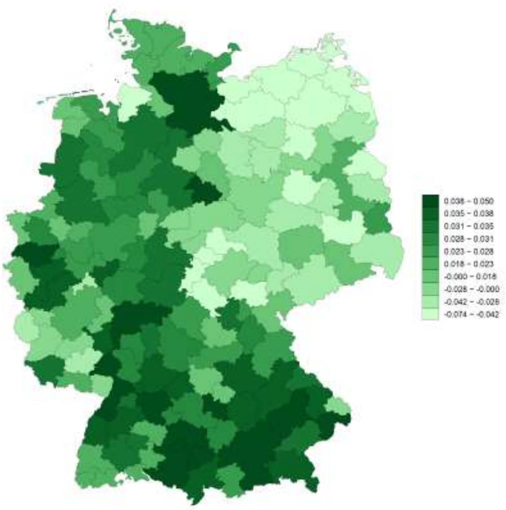
Figure 4: Counterfactual analysis: Regional effects



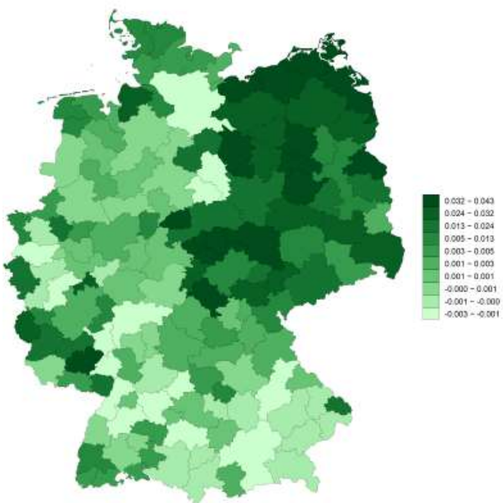
(a) Size of fiscal shock



(b) Population change



(c) Real wage change



(d) Employment rate change

Notes: Panel (a) displays changes in fiscal budgets. The Panels (b) to (d) display percentage changes in total population, employment, and real wages. Real wages are defined as employment-weighted wages over model-consistent regional price levels.

losing about 33,000 inhabitants. In-migration congests local labour markets in *recipient* regions, thereby decreasing male (female) wages by 11 (5) Euros.

The group-specific elasticity $\rho^g_{h,C}$ determines the size of the "fiscal multipliers". As long as it is strictly positive, local spending and public good provision should increase labour participation rates. However, shocks to local after-tax wages simultaneously shift the cut-offs for non-employment downwards, as highlighted in equation (6). Overall, we still observe a slight increase in overall labour force participation. Nonetheless, we observe a slight decrease in per capita fiscal budgets: firstly, the policy re-allocates workers into less productive regions, which decreases local tax revenues. More importantly, rent revenues from land and structures are 0.24% smaller in the counterfactual scenario. As a result, the national portfolio decreases by 0.08% and, in turn, the fiscal capacities of local governments.

Average welfare increases by around 0.12% in the counterfactual scenario. Since workers migrate to the lower productivity parts of the economy, they simultaneously decrease aggregate output, however. Since 30,000 workers join the labour force in *recipient* regions, these regions do experience a GDP expansion, nonetheless.

Aggregate Effects - Absence of Fiscal Multipliers To highlight the effect of the "fiscal multiplier channel", we lastly re-run the counterfactual when forcing $\rho^g_{h,R} = 0$. In this scenario, fiscal budgets cannot affect local labour force participation rates. As a result, we observe a smaller labour force increase following the government policy, mainly coming from smaller female labour force participation. Since real wages (slightly) increase, we find larger welfare effects in this scenario. At the same time GDP falls even further, since aggregate labour supply increases by a smaller margin.

F Conclusion

The literature concerned with spatial policies and public expenditures mainly abstracts from accounting for the local labour force participation channel via fiscal policy. We ask whether local public spending may induce higher labour force participation, decrease spatial disparities and increase overall welfare. If spillovers from local spending to local labour supply ("fiscal multipliers") vary across space, we document that spatial policies may increase efficiency and generate aggregate benefits.

In the theoretical part of the paper, we develop a spatial general equilibrium model of extensive labour supply with multiple types of workers that qualitatively produce these findings. To be more precise, in our model, workers are differently affected by local fiscal budgets and local public goods provision in their extensive labour supply decisions and spatial sorting.

Two conclusions arise from this extension. First, policymakers should not only address the distortionary effects of spatial sorting and taxation in their design of spatial policies. But should also consider the impact of local public expenditure on local labour supply. We

Table 2: Aggregate effects of policy evaluation

	$\rho^g_{h,R} > 0$		$\rho^g_{h,R} = 0$	
	Overall	Recipient	Overall	Recipient
Panel A: Population and Employment				
Δ Population (Male)	0	17,210	0	17,903
Δ Population (Female)	0	16,073	0	17,310
Δ Labour force (Male)	1,016	15,116	-190	14,428
Δ Labour force (Female)	2,875	14,592	1,139	13,644
Δ Labour force participation rate (Male)	0.004	0.007	-0.001	-0.000
Δ Labour force participation rate (Female)	0.011	0.018	0.004	0.006
Panel B: Wages and prices				
Δ Average wage (Male; in €)	-11.59	-11.17	-11.87	-11.43
Δ Average wage (Female; in €)	-6.78	-5.50	-6.68	-5.44
Δ Real wage (Male; in €)	1.49	0.08	1.64	0.22
Δ Real wage (Female; in €)	1.36	0.25	1.52	0.37
Panel C: Aggregate measures				
Δ Fiscal capacities (per capita; in €)	-8.36	42.90	-9.87	41.51
Δ Rent income (in %)	-0.237	-0.012	-0.246	-0.021
Δ National Portfolio	-0.079	-0.079	-0.096	-0.096
Δ Real GDP (in %)	-0.002	0.098	-0.006	0.094
Δ Welfare (Male; in %)	0.117	0.117	0.118	0.118
Δ Welfare (Female; in %)	0.115	0.115	0.118	0.118

Notes: This table shows the absolute change in population and employment, wages and prices, and percentage changes in aggregate measures, like welfare, for male and female workers under counterfactual changes in local tax and transfer rates that implemented the childcare investment program. The first two columns report the counterfactual exercise under $\rho^g_{h,R} > 0$, while the last two columns show results for $\rho^g_{h,R} = 0$.

empirically document that public spending, like investments in infrastructure or childcare, affects extensive labour supply decisions and tax revenue. Using individual employment biographies from official social security records in Germany, we investigate the local non-employment effects in response to shocks to the German fiscal equalization scheme. We exploit the quasi-random Census shock in 2011, which caused sizable changes in population counts and a permanent shock to fiscal transfers with shocks to local public budgets. Using this strategy, we find that females respond stronger than males to (negative) fiscal budget shocks.

Second, distributional concerns arise for the optimal design of spatial policies and local public goods provision since the distribution of benefits and costs across employed and non-employed workers matters.

To assess the equilibrium effect of local fiscal budgets on local employment and their distributional impact, we simulate the model. In our counterfactual computations, we quantify the effects of a large-scale government investment program, which included spatial transfers serving as a prominent example of recent German place-based policies. The primary goal of this public policy was to provide the legal right to a public childcare place for all children over the age of one. Since the program implied substantial re-distribution of public funds from urban areas in the South towards rural and Eastern German regions, we observe sizable worker flows, with donor regions losing about 33,000 inhabitants in our counterfactual simulations. We find that welfare increases, but overall production slightly decreases between the two equilibria as workers migrate to low-productivity regions and sectors, but join the local labour force.

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ONLINE APPENDIX

This section presents an Online Appendix containing complementary material.

H Empirical appendix

H.1 Data

To investigate the impact of changes to fiscal budgets on the local economy, we aggregate yearly official tax data provided by the German Statistical Office and individual employment biographies from official social security records to the level of 401 districts in Germany. Our observation period spans from 2004 to 2019. Later, in the model part of our paper, we aggregate the information to the level of the 141 local labour markets of Germany, which were originally delineated as commuting zones by Kosfeld and Werner (2012). We construct six sectors (four tradable and two non-tradable, based on ISIC Rev. 4) to ensure sufficient data coverage across all region-sector pairs.

H.1.1 Local Public Finance Data

We use official tax data provided by the German Statistical Office and the Federal Statistical Office (see Statistisches Bundesamt (2021b); Statistisches Bundesamt (2021a); Statistische Ämter des Bundes und der Länder (2021a)) to break down tax revenues (federal, state, and local municipalities) to the local level and identify the effective degree of fiscal transfers (within and between the Federal States). We follow the procedure in Henkel et al. (2021) and compute for every district the local tax revenues before and after redistribution (and hence net transfers). We aggregate these variables to the local level to obtain empirical proxies of the average tax revenues and fiscal transfers. Later, in the model part of our paper, we relate them to these regions' labour income to obtain tax and transfer rates per region.

H.1.2 Administrative Labour Market Data

Our main source for wage and employment information is administrative German labour market data provided by the Institute for Employment Research (IAB) at the German Federal Employment Agency. We use the weakly anonymous Sample of Integrated Labour Market Biographies (SIAB).[30] To construct our sample, we identify all individuals between 15 and 65 years old, full-time or part-time employed, that did not die or emigrate during our observation period. We further drop all marginal employment states that are not covered in the data over the whole period. Moreover, we restrict the dataset to only one

[30]This study uses the factually anonymous Sample of Integrated Labour Market Biographies (version 1975 - 2019). Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently remote data Access. DOI: 10.5164/IAB.SIAB7519.de.en.v1

observation for each individual and year, corresponding to the spell with the longest tenure that stretches over June 30th of a given year. To address the censoring of wages at the social security maximum, we apply the imputation method proposed by Card et al. (2013).

For each individual in the data, we retrieve information on gross daily wages, education, gender, age, occupation, sector, workplace, location of residence, as well as detailed information about the employment status. We define workers as non-employed when they are not employed but are actively searching for employment with compulsory social insurance contributions. Further, we count workers as non-employed when they look for a job without being registered as unemployed. Also, all participants in job creation, further training, paternity or sick leave, and retraining measures are described as non-employed.

To calculate the total wage bill per region and sector, we interact average wages per worker-type and industry from the National Accounts (EU KLEMS, see Stehrer et al. (2018)) with region-sector-specific fixed effects. We extract the fixed effects from a standard AKM (Abowd et al., 1999) earnings function (with dummies for three education levels, part-time employment, a cubic age and experience term, and person fixed effects) in an approach similar to Card et al. (2013).

Finally, to obtain a precise picture of regional employment, non-employment, the industry composition, and the workforce characteristics of local labour markets, we aggregate the data to the district-level (or local labour market level). For the quantification of our model, we combine the individual-level information with aggregate employment counts per worker type, industry, and local labour market per year from detailed administrative data of the German Federal Employment Agency (BA). The employment data is available from the Federal Employment Agency ("Bundesagentur für Arbeit") via their online regional database Statistische Ämter des Bundes und der Länder (2021b).

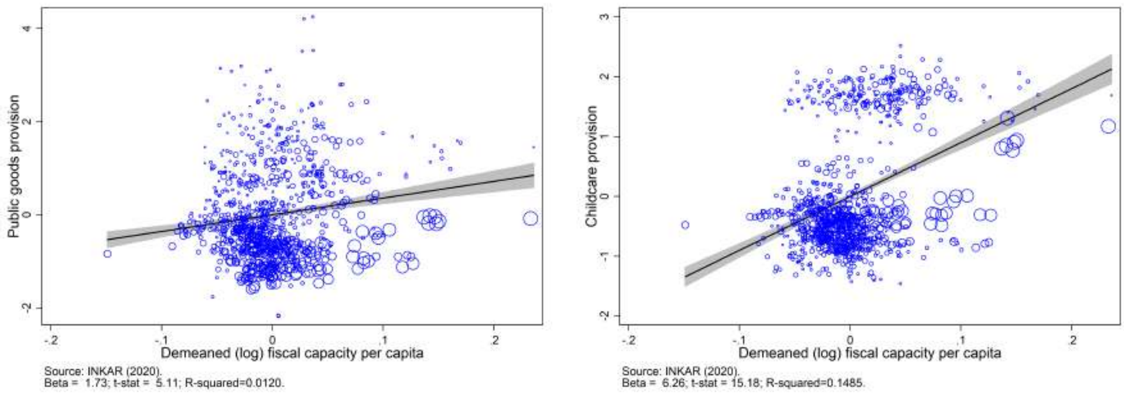
H.2 Local public good provision

Article 28 of the German constitution provides the legal basis for regulating local public goods provision in Germany. It guarantees cities, municipalities, and districts the right of local self-government. As a result, they care for everything that neither the 16 State governments (the "Länder") nor the Federal government are responsible for. At the same time, federal or state laws regulate that the municipalities have to provide their citizens with specific public goods. These include, for example, childcare, elementary schools, drinking, and sewage supply, energy and waste management, a fire department, municipal elections, and social institutions. More specifically, municipalities have to build and maintain a sufficient number of kindergartens, nurseries, schools, and other child care facilities, but how they do this is their own decision. The population size and demographic composition of municipalities define their financial needs.

To determine a single measure of local public goods provision, we convert different measures of public goods to a single measure by taking the first principal component. We collect information on the provision of local public goods, like childcare provision, the ease of reaching the next elementary school, public transportation, motorway, airport, train station, the share of households with broadband internet access, drinking, and sewage supply, energy, and waste management, as well as publicly financed recreational areas from the INKAR (2020) database. We then standardize to give this variable a zero mean and unit standard deviation.

Lower fiscal revenues limit municipalities in providing local public goods, whereas larger fiscal capacities allow higher public spending. Panel (a) of Figure A1 highlights this relationship. Fiscal capacities per capita are normalized by the working-age population in 2008 and demeaned by their yearly average. The positive relationship indicates that a higher budget of local governments allows providing more public goods. When fiscal budgets are tight, there is no alternative but to save on the provision and maintenance of local public goods, like libraries, swimming pools, parks, youth centres, nurseries, and retirement homes.[31] As a case in point, Panel (b) of Figure A1 highlights the importance of sufficient fiscal capacities for local governments to provide public childcare.

Figure A1: Public goods provision and local fiscal capacities per capita



(a) Public goods provision

(b) Childcare provision

Note: Panel (a) plots an aggregate measure of local public goods provision against fiscal capacity per capita, normalized by the working-age population in 2008 and demeaned by their yearly average. Panel (b) links fiscal capacities per capita to a measure of childcare provision. We use available tax revenues after fiscal redistribution to measure fiscal capacities. Local tax revenues and transfer payments are based on our calculations. We follow the approach in Henkel et al. (2021) to calculate fiscal capacities as the sum of local tax revenues before redistribution and regional transfer payments (that is negative for donors and positive for recipients). Public goods and childcare provision are the outcomes of a first principal component analysis on different measures of public good provision, including, among others, various measures of local public childcare in nurseries and kindergartens, access to fast broadband internet, public transport, and highway infrastructure, as well as investment in retirement homes, local recreational areas, or waste management. The size of the marker is proportional to the regional population size in 2008. Data comes from INKAR (2020) and Statistisches Bundesamt (2021b,a); Statistische Ämter des Bundes und der Länder (2021a).

[31]The financial situation of some municipalities deteriorated when Germany introduced the so-called "Schuldenbremse" in 2009. Since then, Article 109 of the German constitution explicitly prescribes the principle of a balanced budget without net borrowing in a given year for the federal and state governments. Moreover, Article 115 of the Constitution limits net borrowing at the federal level to 0.35 % of national GDP; see Busch and Strehl (2019) for an overview.

H.3 First stage of Census shock

The Census shock in 2011 induced a one-off but also permanent shock to fiscal transfers and local government budgets. In Figure A3 we plot the year-to-year change in fiscal transfers against the Census shock to provide some first descriptive evidence of this claim. Higher levels of the Census shock are associated with significantly larger fiscal per capita transfer growth in 2012, the first year when updated population counts are used for transfer calculation (Panel (a)). At the same time, we don't observe a significant impact of the Census on transfers and fiscal budgets in either the pre-shock or the post-shock period in Panels (b) and (c), respectively.

Similarly to Helm and Stuhler (2021) we estimate the dynamic effect of the Census shock on per capita growth of fiscal transfers in an event-study approach, where we run the following regression in first differences:

$$\Delta \text{Transferpc}_{i,t} = c_t + c_{j,t} + \sum_{s=T+k} \beta_s \Delta \ln \text{Census}_{i,2011} \times \mathbb{1}\left[t = s\right] + u_{i,t}. \tag{20}$$

Here ΔTransferpc$_{i,t}$ refers to the per capita growth of fiscal transfers between subsequent years [32], c_t and $c_{j,t}$ are time and state-time fixed effects and $\Delta \ln \text{Census}_{i,2011}$ is the Census shock as defined above. We define all event periods relative to the event year T-1 in which the Census shock occurred and which we take as the reference period. The regression coefficients for $k \in [-8; 7]$ are shown in column (1) of Table 3 and displayed graphically in Panel (a) of Figure A2. There is no statistically significant impact on fiscal transfer growth in pre-periods. Furthermore, we don't observe distinguishable trends before 2011, and coefficients vary around zero. Reassuringly, this implies that the Census shock is unlikely to correlate with shocks to local economic activity that determine the allocation of fiscal transfers.

The coefficient for the year of the fiscal transfer shock is, however, positive, statistically highly significant, and economically meaningful: A one percent larger shock to local population counts increased fiscal transfer growth by approximately 57 EUR. Put differently, an increase of the Census shock by one standard deviation led on average to 15 % higher fiscal transfers per capita in the year 2012.[33]

The Census shock permanently shifts the size of fiscal transfers, since future extrapolations of population counts are to be based on official population numbers from the Census. To assess the aggregate effect of the Census shock, we first define the cumulative change in fiscal transfers relative to the reference period 2011 as

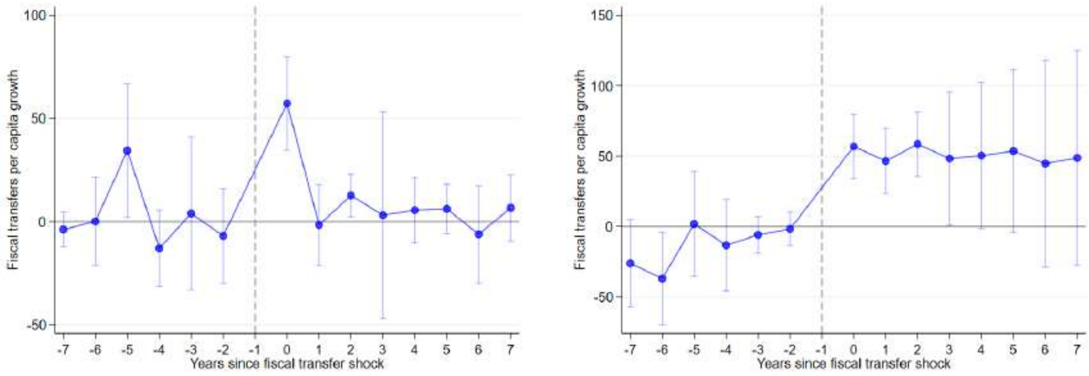
$$\Delta \text{Transferpc}^{\text{cum}}_{i,t} \equiv \frac{\text{Transfer}_{i,t} - \text{Transfer}_{i,2011}}{L_{i,2010}}.$$

[32] To limit reverse causality concerns, we use the pre-Census 2010 population count throughout to calculate fiscal transfers per capita.

[33] This equals an increase of the Census shock by 1.3 percentage points. See Panel B of Table 6 for summary statistics of the Census shock.

Subsequently, we re-run regression equations (20) with $\Delta\text{Transferpc}_{i,t}^{\text{cum}}$ as the dependent variable. We display the coefficients from this regression in column (2) of Table 3 and Panel (b) of Figure A2. Reassuringly, the cumulative effect on fiscal transfers is constant over the post-treatment periods, while none of the coefficients is significantly different from zero. The Census shock thus indeed induced a one-off permanent shock to fiscal transfers that was both unexpected and exogenous to local economic activity.

Figure A2: Impact of Census shock on fiscal transfers



(a) Yearly effect

(b) Cumulative effect

Note: Panel (a) plots the coefficients and 95% confidence intervals of a regression of yearly per capita growth of fiscal transfers on an interaction of the Census shock and a year dummy (controlling for state-year fixed effects). Event periods are defined relative to the year of the Census shock (e.g., $t = -1$ in 2011). In Panel (b), the dependent variable is the cumulative per capita growth in fiscal transfers relative to the year of the Census shock. Standard errors are clustered on the level of regions.

H.4 Difference-in-Difference Analysis

We use triple difference-in-difference regressions to investigate whether female workers in treated regions experienced significantly different local employment effects following the Census shock. To do so, we estimate the following specification

$$\begin{aligned} Y_{i,t}^{g} &= a_0 + a_1 * \text{Female} + a_2 * \text{Post} + a_3 * (\text{Post} \times \text{Female}) + a_4 * \text{Treat} \\ &\quad + a_5 * (\text{Treat} \times \text{Female}) + a_6 * \text{DiD} + a_7 * (\text{DiD} \times \text{Female}) + \beta' X_{i,t}^{g} + u_{i,t}^{g}, \end{aligned} \tag{21}$$

where Female, Post and Treat are dummies for workers being female, living in treated regions and in post-treatment time periods (years after 2011) respectively. The variables DiD and (DiD $\times$ Female) are our main outcome variables and refer to the interaction (Post $\times$ Treat) and the female-specific component of it (when applicable). We use various measures of public good provision, as well as the measures of non-employment defined in section H.1, as dependent variables either in levels or logs . Finally, $X_{i,t}^{g}$ is a vector of control variables, including wages, and $u_{i,t}^{g}$ is a residual. In more demanding specifications we, furthermore, estimate fully-fledged two-way fixed effects model with region-gender and year-gender fixed effects.

Increases in public debt were not significantly more sizeable in treated than control regions, as shown by the difference-in-difference and two-way fixed effects estimates in columns (1) and (2) of Table 5. Local jurisdictions, therefore, did not compensate for decreasing tax and transfer revenues through increased public debt uptake but indeed suffered a permanent decrease in fiscal budgets. Unfortunately, detailed expenditure data of local governments are not available at the county level. Instead, we approximate spending on public good provision with their local supply: we find, for example, that the daycare rates of toddlers (column (3)) or available places in nursing homes (column(4)) experience significantly smaller increases in treated regions following the Census shock.

The non-employment estimates of regression (21) are displayed in column (1) of Table 1. Non-employment rates in treated regions were larger even in pre-treatment periods. Furthermore, across all treatment groups, non-employment rates decreased by approximately 60 % points since 2011. Nonetheless, the reduction in non-employment was significantly smaller in treated regions: non-employment rate decreases of male workers were approximately 10% smaller in those jurisdictions which experienced the largest population decreases, and, in turn, permanent negative shocks to fiscal budgets. Furthermore, the negative Census-induced fiscal budget shock increased local gender employment gaps by around 5 %, since female labour supply is impacted more strongly.

Using only within-state ("Bundesland") variation over time (column (2)) barely changes the estimated coefficients. In column (3), we estimate a fully-fledged two-way fixed effects model with region-gender and year-gender fixed effects. Reassuringly, our DiD estimates are barely affected by this more demanding specification. Finally, we show that the employment effects are not explained by changes in the public employment payroll. The estimated coefficients are displayed in column (4): there is no statistically effect on per-capita public employment.

H.4.1 Fiscal transfer growth and Census shock correlation

H.4.2 Effect of Census shock on transfer and capacity growth

H.4.3 Descriptive statistics for treatment and control regions

Table 1: TRIPLE DIFFERENCE-IN-DIFFERENCE APPROACH

	Non-employment (1)	Non-employment (2)	Non-employment (3)	Public employment (4)
Female	0.187***			
	(0.009)			
Post-treatment	-0.603***	-0.579***		
	(0.018)	(0.018)		
Post-treatment * Female	0.008	-0.012		
	(0.008)	(0.009)		
Treated	0.240***	0.231***		
	(0.050)	(0.039)		
Treated*Female	-0.106***	-0.098***		
	(0.024)	(0.023)		
DiD	0.119***	0.101**	0.099**	0.011
	(0.042)	(0.041)	(0.041)	(0.008)
DiD*Female	0.037*	0.054***	0.055***	
	(0.019)	(0.021)	(0.021)	
Constant	-2.282***			
	(0.024)			
Region-gender fixed effects	no	no	yes	yes
Year-gender fixed effects	no	no	yes	yes
State-gender fixed effects	no	yes	no	no
Controls	no	yes	yes	no
Observations	13338	13338	13338	3123

Notes: This table shows the estimates of the triple difference-in-difference regressions outlined in equation (21) on the natural logarithm of non-employment probabilities in columns (1) - (3) and on the natural logarithm of per-capita public employment in column (4). Instead of dummies for treatment and post-treatment we employ the full set of region-gender and time-gender fixed effects in columns (3) and (4).For the calculation of per-capita public employment we hold regional population counts constant at their pre-Census level in 2010. Standard errors clustered on the level of regions. $^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: THE EFFECT OF THE CENSUS SHOCK 2011 ON NON-EMPLOYMENT

	Δ Non-employment share (Female) (1)	Δ Non-employment share (Male) (2)	ΔNon-employment share (Female) (3)	Δ Non-employment share (Male) (4)
Years: -11 to -10	-0.065	-0.005	-0.060	-0.003
	(0.071)	(0.048)	(0.050)	(0.054)
Years: -9 to -8	-0.056	0.027	-0.049	0.028
	(0.054)	(0.042)	(0.040)	(0.044)
Years: -7 to -6	-0.006	0.020	-0.001	0.024
	(0.029)	(0.029)	(0.022)	(0.023)
Years: -5 to -4	-0.003	0.006	-	-
	(0.012)	(0.009)	-	-
Years: -3 to -2	-0.009	0.005	-	-
	(0.010)	(0.008)	-	-
Year: -1	-	-	-	-
Year: 1	0.064^{+}	0.082^{*}	0.067^{+}	0.080^{*}
	(0.048)	(0.044)	(0.044)	(0.043)
Years: 2 to 3	0.111^{**}	0.090^{+}	0.115^{***}	0.089^{**}
	(0.045)	(0.056)	(0.041)	(0.045)
Years: 4 to 5	0.063	0.090^{+}	0.066^{+}	0.087^{*}
	(0.044)	(0.055)	(0.045)	(0.048)
Years: 5 to 6	0.090^{**}	0.087^{+}	0.094^{**}	0.083^{**}
	(0.045)	(0.056)	(0.043)	(0.042)
Year fixed effects	yes	yes	yes	yes
IPW	yes	yes	yes	yes
RA	no	no	yes	yes
Lags used	1	1	5	5
Observations	11,936	11,936	11,936	11,936

Notes: This table shows the estimates of the Treatment Effect framework regressions on the natural logarithm of the growth in non-employment probabilities. We use inverse probability weighting (IPW) with a probit treatment model in columns (1) and (2). Columns (3) and (4) show the coefficients of a "doubly robust" estimator (IPWRA) which combines inverse probability weighting with a probit treament model and a linear outcome model. We use lags of the outcome variable as well as period effects as explanatory variables for the treatment and outcome models. Event periods are defined relative to the year of the Census shock (e.g., $t = -1$ in 2011). Standard errors are bootstrapped and clustered on the level of regions. $^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: The effect of the Census shock on transfer and capacity growth

	Yearly Growth Transfers (1)	Cumulative Growth Transfers (2)	Yearly Growth Capacities (3)	Cumulative Growth Capacities (4)
$k = -7$	-3.845	-26.044^{+}	-9.910^{+}	19.944*
	(4.295)	(15.819)	(6.253)	(10.380)
$k = -6$	0.103	-36.836**	4.418	23.267**
	(10.920)	(16.755)	(4.394)	(10.806)
$k = -5$	34.404**	1.502	1.895	18.366**
	(16.469)	(18.939)	(8.701)	(9.318)
$k = -4$	-12.928	-13.222	5.502	24.184**
	(9.434)	(16.572)	(6.556)	(9.926)
$k = -3$	3.952	-5.881	-14.486*	9.700
	(18.904)	(6.634)	(8.684)	(8.134)
$k = -2$	-6.942	-1.711	-1.211	10.602*
	(11.686)	(6.065)	(5.980)	(6.278)
$k = -1$	.	.	.	.
$k = 0$	57.259***	56.891***	63.398***	62.183***
	(11.588)	(11.570)	(7.462)	(6.115)
$k = 1$	-1.615	46.544***	-1.532	62.232***
	(10.021)	(11.789)	(5.164)	(7.085)
$k = 2$	12.655**	58.489***	10.593***	70.440***
	(5.313)	(11.668)	(3.736)	(7.370)
$k = 3$	3.114	48.253**	-8.783	57.198***
	(25.594)	(24.131)	(19.864)	(18.995)
$k = 4$	5.562	50.404*	11.638**	64.713***
	(8.048)	(26.506)	(5.082)	(22.613)
$k = 5$	6.161	53.652*	11.740**	72.050***
	(6.138)	(29.483)	(4.657)	(26.180)
$k = 6$	-6.153	44.666	11.607**	78.634**
	(12.047)	(37.426)	(4.451)	(29.976)
$k = 7$	6.646	48.681	10.422**	85.147**
	(8.189)	(38.859)	(4.565)	(33.331)
Period fixed effects	yes	yes	yes	yes
State × Period fixed effects	yes	yes	yes	yes
Observations	5,969	6,384	5,969	6,384

Notes: This table reports the effect of Census shock on fiscal transfers (columns (1)-(2)) and fiscal capacities (columns (3)-(4)) according to equation (20). Event periods are defined relative to the timing of the Census (e.g. $k = -1$ in 2011). Standard errors (in parentheses) are clustered at the level of German counties. $^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: THE EFFECT OF THE CENSUS SHOCK ON (LOG) FISCAL CAPACITY GROWTH

	(Log) Yearly Growth Capacities (1)	(Log) Cumulative Growth Capacities (2)
$k = -7$	-0.001	-0.001
	(0.002)	(0.002)
$k = -6$	0.002*	0.000
	(0.001)	(0.002)
$k = -5$	0.001	0.001
	(0.002)	(0.002)
$k = -4$	0.001*	0.002+
	(0.001)	(0.001)
$k = -3$	-0.001	0.001
	(0.001)	(0.001)
$k = -2$	-0.001	0.001
	(0.001)	(0.001)
$k = -1$	.	.
$k = 0$	0.006***	0.006***
	(0.001)	(0.001)
$k = 1$	-0.001	0.005***
	(0.001)	(0.001)
$k = 2$	0.001	0.006***
	(0.001)	(0.001)
$k = 3$	0.001	0.006***
	(0.001)	(0.002)
$k = 4$	0.001*	0.007***
	(0.001)	(0.002)
$k = 5$	0.001**	0.008***
	(0.000)	(0.002)
$k = 6$	0.001**	0.009***
	(0.000)	(0.003)
$k = 7$	0.001**	0.010***
	(0.000)	(0.003)
Period fixed effects	yes	yes
State × Period fixed effects	yes	yes
Observations	6,384	6,384

Notes: This table reports the effect of Census shock on fiscal capacities (columns (1)-(2)) according to equation (20). Event periods are defined relative to the timing of the Census (e.g. $k = -1$ in 2011). Standard errors (in parentheses) are clustered at the level of German counties. $^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: The effect of the Census shock 2011 on public good provision

	Public debt (1)	Public Debt (2)	Childcare rate (3)	Nursing home places (4)
Post-treatment	0.167^{***}			
	(0.026)			
Treated	0.111			
	(0.089)			
DiD	0.087	0.104	-1.066^{**}	-0.030^{**}
	(0.077)	(0.081)	(0.420)	(0.014)
Constant	6.885^{***}			
	(0.828)			
Region fixed effects	no	yes	yes	yes
Year fixed effects	no	yes	yes	yes
State fixed effects	no	no	no	no
Observations	3454	3454	3159	1755

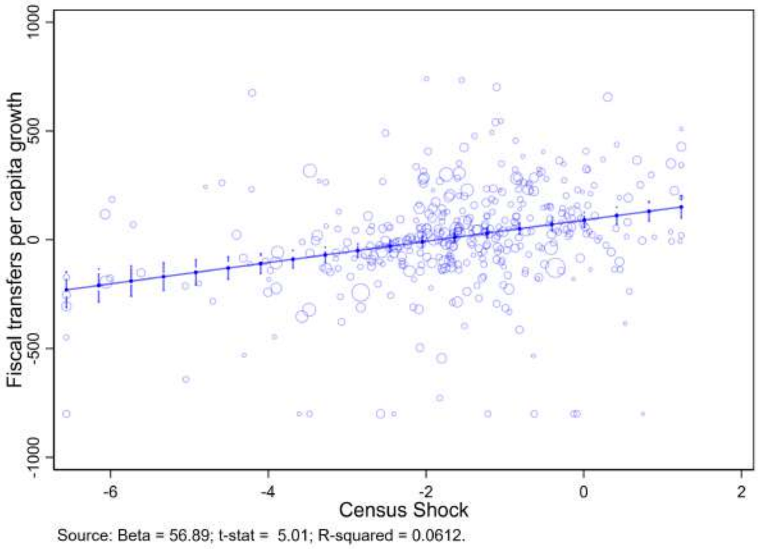
Notes: This table shows the estimates of the triple difference-in-difference regressions outlined in equation (21) on the natural logarithm of per-capita public debt (columns (1)- (2)), childcare rates (column(3)) and the natural logarithm of per-capita nursing home places (column(4)). Childcare rates are defined as the share of toddles (< 3 years) in daycare institutions. For the calculation of per capita public debt and nursing home places we hold regional population counts constant at their pre-Census level in 2010.Standard errors clustered on the level of regions. Data comes from INKAR (2020). $^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: SUMMARY STATISTICS

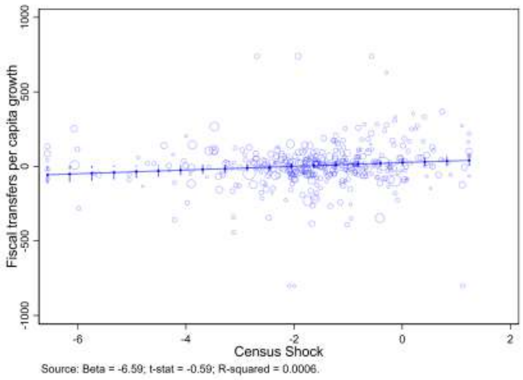
	Treated		Control		Total	
	Mean	Std	Mean	Std	Mean	Std
Panel A: Labour Force Participation						
Δ Labour force participation rate (Female)	0.003	0.006	0.005	0.008	0.005	0.008
Δ Labour force participation rate (Male)	-0.001	0.006	0.001	0.007	0.001	0.007
Δ Relative labour force participation rate	0.004	0.008	0.005	0.007	0.005	0.007
Panel B: Population and Population Growth						
Yearly (Log) Population Growth (2010)	0.001	0.006	-0.003	0.006	-0.002	0.006
Yearly (Log) Population Growth (Census Year)	-0.041	0.012	-0.014	0.009	-0.018	0.014
Yearly (Log) Population Growth (2013)	0.004	0.007	0.001	0.006	0.001	0.006
Census shock (May 2011)	-0.045	0.012	-0.015	0.008	-0.019	0.013
Panel C: Fiscal Capacities and Transfers						
Δ (Log) Fiscal capacities (per capita)	0.119	0.176	0.115	0.177	0.115	0.177
Δ (Log) Fiscal transfers (per capita)	0.022	0.709	0.066	0.615	0.062	0.625
Δ (Log) Public Debt (per capita)	0.317	0.743	0.189	0.560	0.206	0.590
Panel D: Supply of public childcare						
Δ Childcare rate (toddlers)	0.029	0.059	0.031	0.052	0.031	0.053
Δ Childcare rate (3-5 yrs)	-0.045	0.012	-0.015	0.008	-0.019	0.013

Notes: Panel A reports the mean and standard deviation (Std) of time changes in labour force participation rates, relative to the pre-Census year 2010, for all German counties ("Kreise") and workers of both genders, separately for treated and non-treated regions.
Panel B reports the mean and standard deviation (Std) of log population growth and the Census shock for all German counties ("Kreise"), separately for treated and non-treated regions. The Census shock is defined as the log difference in regional population counts at the day of the Census and the last day of the year 2010.
Panel C reports the mean and standard deviation (Std) of log growth in fiscal capacities per capita (regional tax income after fiscal re-distribution), fiscal transfers per capita, as well as their public debt, separately for treated and non-treated regions. Time changes are relative to the pre-Census year 2010 and we hold population counts constant at their 2010 level.
Panel D reports the mean and standard deviation of time changes in childcare rates, relative to their 2010 pre-Census level. Childcare rates are defined as the share of toddlers ($<$ 3 years) and children aged 3-5 years in daycare institutions, relative to the total number of children in the age group in a region.

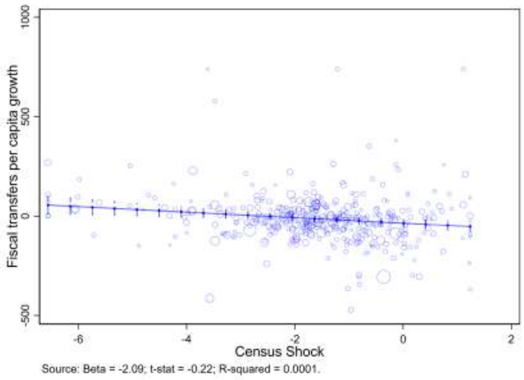
Figure A3: Census shock and fiscal transfers



(a) Fiscal transfer shock period



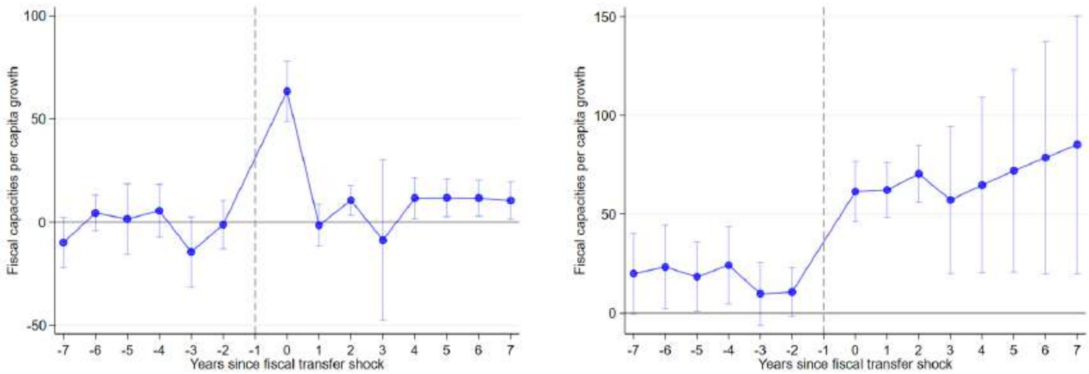
(b) Pre-shock period



(c) Post-shock period

Note: This figure plots demeaned fiscal transfer growth per capita (relative to the state-specific mean) against the identically demeaned Census shock. Panel (a) plots the correlation for 2012, the year of the "fiscal transfer shock" (e.g. the year when population re-counts were first incorporated into the calculation of fiscal transfers). Panel (b) and Panel (c) plot the same correlation for two years before and one period after the fiscal transfer shock. The size of the marker is proportional to the regional population size in 2010.

Figure A4: Impact of Census shock on fiscal capacities



(a) Yearly effect

(b) Cumulative effect

Note: Panel (a) plots the coefficients and 95% confidence intervals of a regression of yearly per capita growth of fiscal capacities on an interaction of the Census shock and a year dummy (controlling for state-year fixed effects). Event periods are defined relative to the year of the Census shock (e.g., $t = -1$ in 2011). In Panel (b), the dependent variable is the cumulative per capita growth in fiscal transfers relative to the year of the Census shock. Standard errors are clustered on the level of regions.

I Theory appendix

I.1 Worker side

I.1.1 Regional worker incomes

From the definition of the preference shifter $\exp\left[\bar{B}^g_{h|i,u}\right]\varphi\left(\omega\right)$ the average home market preference level of workers who choose region $i \in J$ and market sector $u \in M$ in the first stage is given as

$$\frac{1}{L^g_{h|i,u}}\int_1^\infty L^g_{h|i,u}\exp\left[\bar{B}^g_{h|i,u}\right]\varphi\frac{\partial G^g\left(\varphi\right)}{\partial\varphi}d\varphi = \exp\left[\bar{B}^g_{h|i,u}\right]\int_1^\infty \varphi\frac{\partial G^g\left(\varphi\right)}{\partial\varphi}d\varphi$$
$$= \exp\left[\bar{B}^g_{h|i,u}\right]\bar{\varphi}^g,$$

where $G^g\left(\varphi\right)$ is the cumulative distribution function of workers' idiosyncratic preference for non-employment and $L^g_{h|i,u} \leq L^g_{i,u}$ denotes the number of workers joining the home market sector h. Only those workers, whose individual preference draw is above the cut-off $\tilde{\varphi}^g_{s|i,u}$, join the home market sector, such that the average home market preference level can be re-written as

$$\bar{B}^g_{s|i,u} = \frac{\exp\left[\bar{B}^g_{h|i,u}\right]}{1-G^g\left(\tilde{\varphi}^g_{s|i,u}\right)}\int_{\tilde{\varphi}^g_{s|i,u}}^\infty \varphi dG^g\left(\varphi\right),$$

with $L^g_{h|i,u}/L^g_{i,u} = 1-G^g\left(\tilde{\varphi}^g_{s|i,u}\right)$ the share of workers in the home market sector.

Assume now that the idiosyncratic component follows a Pareto distribution with the following group-specific cumulative distribution and density functions:

$$G^g\left(\varphi\right) = 1-\varphi^{-\epsilon^g}$$

$$\frac{\partial G^g\left(\varphi\right)}{\partial\varphi} = \epsilon^g\varphi^{-\epsilon^g-1}$$

Substituting these functional forms into the expression above yields:

$$\int_{\tilde{\varphi}^g_{s|i,u}}^\infty \varphi dG^g\left(\varphi\right) = \int_{\tilde{\varphi}^g_{s|i,u}}^\infty \varphi\left(\frac{\partial G^g\left(\varphi\right)}{\partial\varphi}\right)d\varphi = \epsilon^g\int_{\tilde{\varphi}^g_{s|i,u}}^\infty \varphi^{-\epsilon^g}d\varphi = \frac{\epsilon^g}{\epsilon^g-1}\left(\tilde{\varphi}^g_{s|i,u}\right)^{1-\epsilon^g}.$$

The cut-off preference level is given by equation (6), such that we get:

$$\int_{\tilde{\varphi}^g_{s|i,u}}^\infty \varphi dG^g\left(\varphi\right) = \frac{\epsilon^g}{\epsilon^g-1}\left(\left(\frac{1}{\mathcal{B}^g_{s|i,u}}\right)\left(\left[w^g_{u|i,u}\right]^{\rho^g_{h,C}}\right)^{1-\alpha}\left(\left[R_{u|i,u}\right]^{\rho^g_{h,R}}\right)^{\alpha}\right)^{1-\epsilon^g}.$$

Collecting terms, we arrive at

$$
\begin{aligned}
\bar{B}^g_{s|i,u} &= L^g_{i,u}/L^g_{h|i,u} \exp\left[\bar{B}^g_{h|i,u}\right] \frac{\epsilon^g}{\epsilon^g-1} \left(\left(\frac{1}{\mathcal{B}^g_{s|i,u}} \right) \left(\left[w^g_{u|i,u} \right]^{\rho^g_{h,C}} \right)^{1-\alpha} \left(\left[R_{u|i,u} \right]^{\rho^g_{h,R}} \right)^{\alpha} \right)^{1-\epsilon^g} \\
&= C^g \left(\mathcal{B}^g_{s|i,u} \right)^{\epsilon^g} \exp\left[-\mu^g_{u|i,u} \right] \left[\left(\left[w^g_{u|i,u} \right]^{\rho^g_{h,C}} \right)^{1-\alpha} \left(\left[R_{u|i,u} \right]^{\rho^g_{h,R}} \right)^{\alpha} \right]^{(1-\epsilon^g)} \frac{1}{L^g_{h|i,u}/L^g_{i,u}},
\end{aligned}
$$

where $C^g = \epsilon^g / (\epsilon^g - 1)$ is a group-specific constant.

Combining the average home market preference component with equations (2) we derive expected indirect utility in region i and market sector u as:

$$
\begin{aligned}
\bar{V}^g_{i,u}(\omega) &= \Psi^g_{i,u}(\omega) \left(\left(1 - \xi^g_{h|i,u} \right) V^g_{u|i,u} + \xi^g_{i,h|u} V^g_{h|i,u} \right) \\
&= \Psi^g_{i,u}(\omega) \bar{A}^g_i \exp\left[-\mu^g_{u|i,u} \right] \left(\frac{I^g_{u|i,u}}{P_i} \right)^{1-\alpha} \left(\frac{R_{u|i,u}}{L^X_i} \right)^{\alpha} \left(1 + \xi^g_{h|i,u} \left[\frac{\epsilon^g}{\epsilon^g - 1} - 1 \right] \right) \\
&= V^g_{u|i,u} \left(1 + \xi^g_{h|i,u} \left[\frac{\epsilon^g}{\epsilon^g - 1} - 1 \right] \right).
\end{aligned}
$$

Equation (16) follows immediately. In the limit case where all workers join the labour force ($\xi_{h|i,u} \to 0$), the expected utility of workers who chose region i and market sector u simply equals the average utility of market sector workers. In this case, higher real income, public services and regional amenities, relative to market participation costs, increase the attractiveness of regions.

In all other cases, the conditional probability of joining the home market sector, $\xi^g_{h|i,u}$, additionally shifts expected indirect utility. This additional utility component accounts for the negative externality employed workers impose on the consumption possibilities of all other region-i-inhabitants. Employed workers use public services (such as infrastructure and childcare facilities) more extensively and, as a result, congest per capita local public good provision to a larger extent. Given similar real income, amenities and public expenditure, workers, therefore, would prefer to be surrounded by non-employed workers (who congest public goods to a smaller extent).

All else equal, larger home market preferences $\exp\left[\bar{B}^g_{h|i,u}\right]$ increase the probability of joining the home market sector h in region i $\xi^g_{h|i,u} \equiv L^g_{h|i,u}/L^g_{i,u}$ (for workers that joined the market sector u in the first stage). In turn, they, therefore, also shift the expected utility $\bar{V}^g_{i,u}(\omega)$, similar to regional amenities. Higher average after-tax income and public expenditures affect expected utility via two opposing channels: firstly, the increase market sector utility firstly but at the same time also decrease the likelihood of joining the home market sector h, which increases public good congestion. The size of the negative externality is governed by the individual heterogeneity in home market preferences: the larger the variance in preference shocks (small ϵ^g), the smaller the labour supply elasticities and in turn the fewer workers join the labour force following (positive) public spending or wage income shocks. This, therefore, decreases the size of the negative externalities.

I.1.2 Distribution of utilities in market sectors

From (16) indirect utility from working in region i and working in sector s is given as:

$$\bar{V}^g_{i,u}(\omega) = \Psi^g_{i,u}(\omega)\,\bar{V}^g_{i,u} = \Psi^g_{i,u}(\omega)\,\bar{A}^g_i \exp\left[-\mu^g_{u|i,u}\right]\left(\frac{I^g_{u|i,u}}{P_i}\right)^{1-\alpha}\left(\frac{R_{u|i,u}}{L^X_i}\right)^{\alpha}\left(1+\xi^g_{h|i,u}\left[\frac{\epsilon^g}{\epsilon^g-1}-1\right]\right)$$

There are $d = 1,..,D$ possible region-occupation pairs $\{i,s\}$ (with $D = JxM$) where workers can self-select and sort into. Workers choose the region-occupation pair d that maximizes idiosyncratic utility.

We then define as $F^g(v_1,...,v_D)$ the cumulative distribution function of indirect utilities for workers of type g:

$$\begin{aligned}
F^g(\mathbf{v_d}) &= \mathbb{P}\left(V^g_1(\omega)\leq v_1,...,V^g_D(\omega)\leq v_D\right) = \mathbb{P}\left(\Psi^g_1(\omega)\,\bar{V}^g_1 \leq v_1,...,\Psi^g_D(\omega)\,\bar{V}^g_D \leq v_D\right)\\
&= \mathbb{P}\left(\Psi^g_1(\omega)\leq \frac{v_1}{\bar{V}^g_1},...,\Psi^g_D(\omega)\leq\frac{v_D}{\bar{V}^g_D}\right),
\end{aligned}$$

Under the assumption of a Fréchet distribution for the idiosyncratic human capital draws the joint distribution of utility is

$$F^g(\mathbf{v_d}) = \exp\left\{-\left[\sum_{u=1}^{M}\sum_{i=1}^{J}\Omega^g_{i,u}\,(v_{i,u})^{-\theta^g}\right]\right\}, \tag{22}$$

where $\Omega^g_{i,u} = \left[\bar{V}^g_{i,u}\right]^{\theta^g}$ is a function of expected group-specific preference components and average wages, local public goods as well as regional price levels for region-occupation pair $\{i,s\}$.

I.1.3 Expected utility

We are interested in the expected utility of individuals of a group g if employed workers choose region-sector pairs $\{i,u\}$ to maximize utility. The expected utility is given as:

$$\begin{aligned}
E^g\left[v_{i,u}\Big|_{k=v_{i,u},\forall i,u}\right] \equiv E^g[k] &= \int_0^\infty v_{i,u}\frac{\partial}{\partial v_{i,u}}\exp\left\{-\left[\sum_{u=1}^{M}\sum_{i=1}^{J}\Omega^g_{i,u}\,(v_{i,u})^{-\theta^g}\right]\right\}\Big|_{k=v_{i,u},\forall i,s}dk\\
&= \int_0^\infty \theta^g k^{-\theta^g}\left[\sum_{u\in M}\sum_{i\in J}\Omega^g_{i,u}\right]\exp\left\{-\left[\sum_{u=1}^{M}\sum_{i=1}^{J}\Omega^g_{i,u}\right]k^{-\theta^g}\right\}dk.
\end{aligned}$$

Re-defining variables

$$z^g = \left[\sum_{u\in M}\sum_{i\in J}\Omega^g_{i,u}\right]k^{-\theta^g} \quad \text{and} \quad dz^g = -\theta^g\left[\sum_{u\in M}\sum_{i\in J}\Omega^g_{i,u}\right]k^{-\theta^g-1}dk,$$

we get

$$E^g[k] = \int_0^\infty \exp\Big\{ - z^g\Big\} \Bigg[\sum_{u\in M}\sum_{i\in J}\Omega^g_{i,u}\Bigg]^{\frac{1}{\theta^g}} (z^g)^{-\frac{1}{\theta^g}}\, dz^g$$

$$= \Bigg[\sum_{u\in M}\sum_{i\in J}\Omega^g_{i,u}\Bigg]^{\frac{1}{\theta^g}} \Gamma\left(\frac{\theta^g - 1}{\theta^g}\right),$$

where $\Gamma(.)$ denotes the Gamma function.

I.1.4 Region-sector shares

We are interested in the probability that a choice of region-occupation pair d is the maximum among all alternatives:

$$\begin{aligned}
\frac{L^g_d}{L^g} &= Pr\{\bar{V}^g_d(\omega) \geq \max_{n\in D\backslash d} \bar{V}^g_n(\omega)\} \\
&= \int_0^\infty \exp\Big\{ - \Big[\sum_{u=1}^{M}\sum_{i=1}^{J}\Omega^g_{i,u}\Big]u^{-\theta^g}\Big\}\Omega^g_{i,u}\theta^g k^{-\theta^g-1}dk \\
&= \frac{\Omega^g_{i,u}}{\sum_{u=1}^M\sum_{i=1}^J\Omega^g_{i,u}}\int_0^\infty \exp\Big\{ - \Big[\sum_{u=1}^{M}\sum_{i=1}^{J}\Omega^g_{i,u}\Big]k^{-\theta^g}\Big\}\Big[\sum_{u=1}^{M}\sum_{i=1}^{J}\Omega^g_{i,u}\Big]\theta^g k^{-\theta^g-1}dk \\
&= \frac{\Omega^g_{i,u}}{\sum_{u=1}^M\sum_{i=1}^J\Omega^g_{i,u}}.
\end{aligned}$$

Equation (18) follows directly.

I.2 Production side

I.2.1 Derivation of unit costs

In this appendix, we derive optimal unit costs under the imperfect substitutability of labour types. Intermediate good producers minimize costs, which yields the following first-order conditions for input demand

$$\delta_{i,u}\kappa_{i,u} = \frac{r_i h_{i,u}(z_{i,u})}{\lambda_{i,u}y_{i,u}(z_{i,u})}$$

$$\delta_{i,uu'} = \frac{P_{i,u'}M_{i,uu'}(z_{i,u})}{\lambda_{i,u}y_{i,u}(z_{i,u})}$$

$$\delta_{i,u}(1-\kappa_{i,u})\frac{\partial l_{i,u}(z_{i,u})}{\partial L^g_{u|i,u}(z_{i,u})} = \frac{w^g_{u|i,u}l_{i,u}(z_{i,u})}{\lambda_{i,u}y_{i,u}(z_{i,u})},$$

where

$$\frac{\partial l_{i,u}(z_{i,u})}{\partial L^g_{u|i,u}(z_{i,u})} = \left(T^g_{i,u}\right)^{\frac{\sigma^g-1}{\sigma^g}}\left(L^g_{u|i,u}(z_{i,u})\right)^{-\frac{1}{\sigma^g}}(l_{i,u}(z_{i,u}))^{\frac{1}{\sigma^g}},$$

and $\lambda_{i,u}$ denotes the Lagrange multiplier of the cost minimization problem, which in our problem corresponds to the price of the input bundle as well. This allows deriving type-specific labour demand as:

$$L^g_{u|i,u}(z_{i,u}) = \frac{l_{i,u}(z_{i,u})}{T^g_{i,u}} \left(\frac{\delta_{i,u}(1-\kappa_{i,u})\lambda_{i,u} y_{i,u}(z_{i,u}) T^g_{i,u}}{w^g_{u|i,u} l_{i,u}(z_{i,u})} \right)^{\sigma^g}.$$

Substituting into $l_{i,u}$ we obtain optimal labour demand as:

$$l^\star_{i,u} = \delta_{i,u}(1-\kappa_{i,u})\lambda_{i,u} y_{i,u}(z_{i,u}) \left[\sum_{g\in G} \left(\frac{T^g_{i,u}}{w^g_{u|i,u}} \right)^{\sigma^g - 1} \right]^{\frac{1}{\sigma^g - 1}}.$$

The first order conditions for workers of all types are then:

$$\delta_{i,u}(1-\kappa_{i,u}) \frac{\left(\frac{T^g_{i,u}}{w^g_{u|i,u}} \right)^{\sigma^g - 1}}{\sum_{g\in G} \left(\frac{T^g_{i,u}}{w^g_{u|i,u}} \right)^{\sigma^g - 1}} = \frac{w^g_{u|i,u} L^g_{u|i,u}(z_{i,u})}{\lambda_{i,s} y_{i,u}(z_{i,u})}.$$

Plugging the optimal input factor demands into the production function we derive the price of the input bundle of production of an intermediate goods produced in region i and market sector u as

$$\lambda_{i,u} = D_{i,u} \left(r_i^{\kappa_{i,u}} \left[\sum_{g\in G} \left(\frac{T^g_{i,u}}{w^g_{u|i,u}} \right)^{\sigma^g - 1} \right]^{\frac{1-\kappa_{i,u}}{1-\sigma^g}} \right)^{\delta_{i,u}} \prod_{u'\in M} \left[P_{i,u'} \right]^{\delta_{i,uu'}},$$

with $D_{i,u} \equiv \left(\delta_{i,u} (\kappa_{i,u})^{\kappa_{i,u}} (1-\kappa_{i,u})^{(1-\kappa_{i,u})} \right)^{-\delta_{i,u}} \prod_{u'\in M} (\delta_{i,uu'})^{-\delta_{i,uu'}}$ a region-sector-specific constant.

I.2.2 Derivation of the ideal cost index

In this appendix we derive the ideal cost index $P_{i,u}$, following the steps outlined in Eaton and Kortum (2002). Let $Y_{i,u}$ denote the quantity produced of final goods in region-sector pair $\{i,u\}$ and as $\tilde{y}_{i,u}(\mathbf{z_u}) = \sum_{j\in J} \tilde{y}_{ij,u}(\mathbf{z_u})$ the aggregated amount demanded of an intermediate good produced by firms in all regions j. Final good production is therefore

$$Y_{i,u} = \left(\int (\tilde{y}_{i,u}(\mathbf{z_u}))^{\frac{\sigma-1}{\sigma}} d\phi_u(\mathbf{z_u}) \right)^{\frac{\sigma}{\sigma-1}}, \tag{23}$$

where $\phi_u(\mathbf{z_u})$ denotes the joint cumulative distribution function for the vector of efficiencies $\mathbf{z_u}$ with marginal functions $\phi_{i,u}(z_{i,u})$ and where σ denotes the elasticity of substitution between varieties. Using the CES assumption, the corresponding demand function for a variety produced in region i and occupation u is

$$\tilde{y}_{i,u}\left(\mathbf{z_u}\right) = \left(\frac{p_{i,u}\left(\mathbf{z_u}\right)}{P_{i,u}}\right)^{-\sigma} Y_{i,u}, \tag{24}$$

where $p_{i,u}\left(\mathbf{z_u}\right)$ equals the unit cost paid by a final good producer and

$$P_{i,u} \equiv \left[\int \left(p_{i,u}\left(\mathbf{z_u}\right)\right)^{1-\sigma} d\phi_u\left(\mathbf{z_u}\right)\right]^{\frac{1}{1-\sigma}}$$

is the ideal cost index for final goods.

Let $G_{ij,u}\left(p\right)$ be the probability that firms located in region j can offer producers in region i an intermediate variety for a price lower than p. Under the assumptions of perfect competition and a Fréchet distribution of productivities it then holds that:

$$\begin{aligned} G_{ij,u}\left(p\right) &= Pr\left\{p_{ij,u}\left(z_{j,u}\right) \leq p\right\} \\ &= 1 - \phi_{ij,u}\left(\frac{\lambda_{j,u}\tau_{ij,u}}{p}\right) \\ &= 1 - \exp\left\{-\left(\frac{\lambda_{j,u}\tau_{ij,u}}{p}\right)^{-\nu_u}\right\}. \end{aligned}$$

Producers in region i buy intermediate varieties from least cost origins. The probability that producers in region i end up paying a price less than p for the variety is

$$\begin{aligned} G_{i,u}\left(p\right) &= 1 - \prod_{n\in J}\left(1 - G_{in,u}\left(p\right)\right) \\ &= 1 - \exp\left\{-p^{\nu_u}\Phi_{i,u}\right\}, \end{aligned}$$

where $\Phi_{i,u} = \sum_{n\in J}\left(\lambda_{n,u}\tau_{in,u}\right)^{-\nu_u}$ is a function of unit prices of production, local productivity and bilateral trade costs.

Substituting the distribution of prices into the ideal cost index yields:

$$P_{i,u}^{1-\sigma} = \nu_u\Phi_{i,u}\int p^{\nu_u-\sigma}\exp\left\{-p^{\nu_u}\Phi_{i,u}\right\}dp.$$

We re-define $x_{i,u} \equiv p^{\nu_u}\Phi_{i,u}$, so with a change of variable we get:

$$\begin{aligned} P_{i,u}^{1-\sigma} &= \int\left(\frac{x_{i,u}}{\Phi_{i,u}}\right)^{\frac{1-\sigma}{\nu_u}}\exp\left\{-x_{i,u}\right\}dx_{i,u} \\ &= \Gamma\left(\frac{\nu_u+1-\sigma}{\nu_u}\right)\left(\Phi_{i,u}\right)^{-\frac{1-\sigma}{\nu_u}}. \end{aligned}$$

The ideal cost index is therefore derived as

$$P_{i,u} = \Gamma\left(\frac{\nu_u+1-\sigma}{\nu_u}\right)^{\frac{1}{1-\sigma}}\left[\sum_{j\in J}\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}\right]^{-\frac{1}{\nu_u}},$$

as in equation (12).

I.2.3 Trade shares

We are interested in the fraction of region-i expenditure accruing to region j in all sectors. Define as $\pi_{ij,u}$ the probability that region j is the least-cost provider of a variety for use as intermediate input in region i and sector u:

$$\begin{aligned}\pi_{ij,u} &= Pr\left\{p_{ij,u}\left(z_{j,u}\right) \leq \min_{n\in J\backslash j} p_{in,u}\left(z_{n,u}\right)\right\} \\ &= \int \prod_{n\in J\backslash j}\left(1-G_{in,u}\left(p\right)\right) dG_{ij,u}\left(p\right)\end{aligned}$$

Substituting in the distribution of prices across regions yields:

$$\begin{aligned}\pi_{ij,u} &= \left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}\int \nu_u p^{\nu_u-1}\exp\left\{-p^{\nu_u}\Phi_{i,u}\right\}dp \\ &= \frac{\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}}{\Phi_{i,u}}\left[-\exp\left\{-p^{\nu_u}\Phi_{i,u}\right\}\right]_0^\infty \\ &= \frac{\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}}{\Phi_{i,u}}.\end{aligned}$$

The expression implies that regions with lower unit costs will comprise a larger fraction of the number of varieties sold to region i. Note that the fraction of *varieties* sold to region i from region j need not generally equal the fraction of i's expenditure spent on region j varieties. Nonetheless, under the assumption that efficiencies follow a Fréchet distribution, it turns out that it does, due to the fact that the distribution of prices for region i is *independent of the origin* (Eaton and Kortum (2002)).

As a result the fraction of varieties that final good producers in region i and sector u purchase from region j equals its fraction of expenditure on goods from region j. Therefore it holds that

$$\pi_{ij,u} = \frac{X_{ij,u}}{X_{i,u}} = \frac{\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}}{\Phi_{i,u}},$$

where we denote as $X_{ij,u}$ the expenditure spent by final good producers in region i and sector u on intermediates produced in region j and $X_{i,u}$ are total expenditures. Finally note that $\Phi_{i,u} = \left(\frac{P_{i,u}}{\Gamma\left(\frac{\nu_u+1-\sigma}{\nu_u}\right)^{\frac{1}{1-\sigma}}}\right)^{-\nu_u}$, which yields a gravity equation for intermediate trade:

$$\pi_{ij,u} = \frac{X_{ij,u}}{X_{i,u}} = \Gamma\left(\frac{\nu_u+1-\sigma}{\nu_u}\right)^{-\frac{\nu_u}{1-\sigma}}\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u}\left(P_{i,u}\right)^{\nu_u}.$$

I.3 Market Clearing

In a spatial equilibrium, it holds that

1. Workers optimally choose bundles of final goods from all markets according to (1), given region-sector-specific price indices and after-tax income;

2. Workers optimally self-select into sectors and locations according to (18);

3. Workers decide about their extensive labour supply after their initial workplace decision according to (7);

4. Intermediate good producers demand materials, labour and land and structures under unit prices (10). These productive inputs are used to produce idiosyncratic intermediate good varieties according to (8) and (9);

5. Final goods producers import intermediates from the least cost intermediate producers according to equation (13);

6. Final good producers optimally choose input varieties given optimal price indices in (12);

7. Final goods market clearing implies

$$\begin{aligned} X_{i,u'} =& \beta^R_{u'}\Bigg[(\mathcal{T}_i+\rho_i)\left(\sum_{s\in h,u}\sum_{u\in M}\sum_{g\in G} w^g_{s|i,u}L^g_{s|i,u}\right) \\ &+\iota_i\left(\sum_{j\in J}\sum_{u\in M}\left(\mathcal{H}_{j,u}r_j-\sum_{g\in G}\left(w^g_{u|j,u}\right)^{1-\rho^g_{h,C}}\xi^g_{h|j,u}L^g_{j,u}\right)\right)\Bigg] \\ &+\beta^C_{u'}\left[(1-\mathcal{T}_i)\sum_{s\in h,u}\sum_{u\in M}\sum_{g\in G} w^g_{s|i,u}L^g_{s|i,u}\right]+\sum_{u\in M}\delta_{i,u'u}\sum_{j\in J}\pi_{ji,u}X_{j,u}, \end{aligned}$$

where the first two terms in squared brackets denote final consumption demand in region i by local governments and consumers respectively and where the third term denotes the demand for goods produced in market u' and region i as material inputs in all regions and market sectors $u \in M$;

8. Labour market-clearing on the production side implies

$$L^g_{u|i,u} = \frac{\delta_{i,u}\left(1-\kappa_{i,u}\right)}{w^g_{u|i,u}}\frac{\left(\frac{T^g_{i,u}}{w^g_{u|i,u}}\right)^{\sigma^g-1}}{\sum_{g\in G}\left(\frac{T^g_{i,u}}{w^g_{u|i,u}}\right)^{\sigma^g-1}}\sum_{j\in J}\pi_{ji,u}X_{j,u}, \tag{25}$$

where $\sum_{j\in J}\pi_{ji,u}X_{j,u}$ are revenues from each export market. Labour market clearing for all groups $g \in G$, regions $i \in J$ and market sectors $u \in M$ ensures that labour supply equals labour demand. Aggregate labour market clearing for workers of all groups implies that workers are either in one of the M market sectors or the home-market sector, such that $L^g = \sum_{i\in J}\left(L^g_{i,h}+L^g_{i,m}\right) = \sum_{i\in J}\sum_{s\in S}\left(L^g_{i,s}\right)$;

9. Market clearing for land and structures implies

$$\mathcal{H}_{i,u} = \frac{\delta_{i,u}\kappa_{i,u}}{r_i}\sum_{j\in J}\pi_{ji,u}X_{j,u}. \tag{26}$$

Land and structures market clearing for all regions $i \in J$ and market sectors $u \in M$ ensures that demand for land and structures (26) equals exogenous supply of land and structures $\bar{\mathcal{H}}_i = \sum_{u\in M}\mathcal{H}_{i,u}$.

I.4 Aggregate equilibrium under selection and sorting

The spatial equilibrium of the model is summarized by the following equations and sets of model-implied variables:

$$L^g_{s|i,u}I^g_{s|i,u} = L^g_{s|i,u}\sum_{u'=1}^{M}P_{i,u'}C^g_{s,u'|i,u} \qquad \text{(Worker expenditure: G x J x 2M)} \tag{27}$$

$$P_i = \prod_{u'=1}^{M}(P_{i,u'}/\beta^C_{u'})^{\beta^C_{u'}} \qquad \text{(Regional price level: J)} \tag{28}$$

$$L^g_{i,u} = \frac{\left(\bar{V}^g_{i,u}\right)^{\theta^g}}{\sum_{u\in M}\sum_{i\in J}\left(\bar{V}^g_{i,u}\right)^{\theta^g}}L^g \qquad \text{(Labour supply: G x J x M)} \tag{29}$$

$$L^g_{h|i,u} = \left[\left(\frac{1}{\mathcal{B}^g_{s|i,u}}\right)\left(\left[w^g_{u|i,u}\right]^{\rho^g_{h,C}}\right)^{1-\alpha}\left(\left[R_{u|i,u}\right]^{\rho^g_{h,R}}\right)^{\alpha}\right]^{-\epsilon^g}L^g_{i,u} \quad \text{(Home market: G x J x M)} \tag{30}$$

$$L^g_{u|i,u} = \frac{\delta_{i,u}\left(1-\kappa_{i,u}\right)}{w^g_{u|i,u}}\frac{\left(\frac{T^g_{i,u}}{w^g_{u|i,u}}\right)^{\sigma^g-1}}{\sum_{g\in G}\left(\frac{T^g_{i,u}}{w^g_{u|i,u}}\right)^{\sigma^g-1}}\sum_{j\in J}\pi_{ji,u}X_{j,u}, \quad \text{(Labour demand: G x J x M)} \tag{31}$$

$$\sum_{u\in M}\mathcal{H}_{i,u} = \mathcal{H}_i \qquad \text{(Supply of land and structures: J)} \tag{32}$$

$$\mathcal{H}_{i,u} = \frac{\delta_{i,u}\kappa_{i,u}}{r_i}\sum_{j\in J}\pi_{ji,u}X_{j,u} \qquad \text{(Demand for land and structures: J x M)} \tag{33}$$

$$M_{i,uu'} = \frac{\delta_{i,uu'}}{P_{i,u'}} \sum_{j\in J} \pi_{ji,u} X_{j,u} \qquad \text{(Demand for materials: J x } M^2\text{)} \tag{34}$$

$$P_{i,u} = \Gamma\left(\gamma_u\right)^{\frac{1}{1-\sigma}} \left[\sum_{j\in J} \left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u} \left(T_{j,u}\right)^{\delta_{j,u}\nu_u}\right]^{-\frac{1}{\nu_u}} \qquad \text{(Sectoral prices: J x M)} \tag{35}$$

$$\pi_{ij,u} = \frac{X_{ij,u}}{X_{i,u}} = \frac{\left(\lambda_{j,u}\tau_{ij,u}\right)^{-\nu_u} \left(T_{j,u}\right)^{\delta_{j,u}\nu_u}}{\sum_{n\in J} \left(\lambda_{n,u}\tau_{in,u}\right)^{-\nu_u} \left(T_{n,u}\right)^{\delta_{n,u}\nu_u}} \qquad \text{(Trade shares: } J^2 \text{ x M)} \tag{36}$$

$$\begin{aligned} X_{i,u'} =& \beta^R_{u'} \Bigg[\left(\mathcal{T}_i + \rho_i\right) \left(\sum_{s\in h,u} \sum_{u\in M} \sum_{g\in G} w^g_{s|i,u} L^g_{s|i,u} \right) \\ &+ \iota_i \left(\sum_{j\in J} \sum_{u\in M} \left(\mathcal{H}_{j,u} r_j - \sum_{g\in G} \left(w^g_{u|j,u} \right)^{1-\rho^g_{h,C}} \xi^g_{h|j,u} L^g_{j,u} \right) \right) \Bigg] \\ &+ \beta^C_{u'} \left[\left(1 - \mathcal{T}_i\right) \sum_{s\in h,u} \sum_{u\in M} \sum_{g\in G} w^g_{s|i,u} L^g_{s|i,u} \right] + \sum_{u\in M} \delta_{i,u'u} \sum_{j\in J} \pi_{ji,u} X_{j,u} \quad \text{(Goods market: J x M)} \end{aligned} \tag{37}$$

$$\sum_{j\in J} \pi_{ji,u} X_{j,u} = \lambda_{i,u} \left[\left(h_{i,u}\right)^{\kappa_{i,u}} \left(l_{i,u}\right)^{1-\kappa_{i,u}} \right]^{\delta_{i,u}} \prod_{u'\in M} \left[M_{i,uu'}\right]^{\delta_{i,uu'}} \quad \text{(Production: J x M)} \tag{38}$$

J Quantification appendix

J.1 Data

This section complements Section D in the main paper. For the model quantification, we require five sets of data compiled for consistent spatial units and sectors: Employment, non-employment, wages, tax revenues and fiscal transfers, bilateral trade flows, and value-added for each region-sector pair. Additionally, we use data on region-specific land rents and aggregate price levels to derive prices and unit costs of non-tradable sectors.

Employment. We use data on the number of workers of both genders $L^g_{i,u}$ employed in labour market i and market sector u. Employment data is available from the Federal Employment Agency ("Bundesagentur für Arbeit") via their online regional database Statistische Ämter des Bundes und der Länder (2021b) for all NUTS-3 regions. We focus on the 141 commuting zones as the empirical equivalent to the J regions of the model framework (Kosfeld and Werner, 2012). We use the Standard Classification of all Economic Activities (ISIC, Rev. 4) to construct six sectors, which we use as the data equivalent to the "market sectors" introduced in the model framework. Table 7 summarizes how we aggregate the ISIC 4 Sectors into our six "market sectors". Sectors 1-4 are tradable, whereas sectors 5 and 6 consists of non-tradables.

Table 7: ISIC Revision 4 Sector Classification

Description	Sector	Classification ISIC Revision 4
Agriculture, Forestry and Fishing	Agriculture	A
Mining and Quarrying Electricity, gas, steam and air conditioning supply Water supply; sewerage, waste management and remediation activities	Mining and Quarrying	B,D,E
Manufacturing	Manufacturing	C
Wholesale and retail trade; repair of motor vehicles and motorcycles Transportation and Storage Accommodation and food service activities Information and communication	Wholesale/ Retail Trade	G-J
Construction	Construction	F
Financial and insurance activities Real estate activities Professional, scientific and technical activities Administrative and support service activities Public administration and defence; compulsory social security Education Human health and social work activities Arts, entertainment and recreation Other service activities Activities of households as employers Activities of extraterritorial organizations and bodies	Non-tradable and Non-market Services	K-U

Notes: This table displays the six sectors: Agriculture (A), Mining (B/D/E), Manufacturing (C) Wholesale/Retail Trade (G - J), Construction (F) and Non-tradable and non-market services(K - U). Sectors 1 - 4 are tradable sectors, sectors 5 & 6 are non-tradable sectors.

Material inputs. Data on gross output comes from the Growth and Productivity Accounts (EU KLEMS, see Stehrer et al. (2018)). Gross value-added per region-sector pair comes from the regional economic accounts provided by the Statistical Office of the European Union (Eurostat). To calculate local levels of gross output, we allocate sector-specific gross output across regions according to region-specific value-added shares. Information on input-output linkages between sectors comes from the World Input-Output Tables (WIOD, see Timmer et al. (2015)).

Trade Flows. The identification of bilateral trade costs and regional gross output requires information on the entirety of interregional trade flows for all tradable sectors to match the expenditures in the model, $\sum_{j\in J} \pi_{ji,u} X_{j,u}$. We use observed bilateral trade shares to allocate the region-sector-specific gross output from the EU KLEMS database across trading pairs.

The Clearing House of Transport Data at the Institute of Transport Research of the German Aerospace Center provides infomration on the entirety of bilateral trade that went through German territory in 2010. See their final report for the Forecast of Nationwide Transport Relations in Germany 2030 ('Verkehrsverflechtungsprognose 2030', henceforth VVP). It provides information on interregional trade volumes in metric tons between German districts in 2010 (Schubert et al. (2014)). To match our empirical equivalents of regions and sectors, we aggregate trade flows to the commuting zone and sector level.

As an input to the theoretical model, we require trade *values* rather than volumes, so we convert the data using appropriate unit values. We base our measure of region-sector-specific unit values on actual output data, such that the information on the volume of bilateral trade flows obtained from the VVP directly matches aggregate region-sector-specific output. We aggregate trade data to the level of local labour market regions and ISIC Revision 4 sectors to resemble our classification of region-sector pairs.

Price levels of non-tradables. We consider two non-tradable sectors: Construction and non-tradable services (for example, Finance and Insurance, Public Administration, and Education). We use the Ahlfeldt et al. (2020) mix-adjusted regional real estate price indices for all German regions as a proxy for local price levels in the construction sector.[34] For price levels of non-tradable services, we rely on estimates of price level differences by sector in Weinand and Auer (2020). We control for tradable service prices and aggregate them to the regional level. Since unit costs can only be identified up-to-scale, we finally re-scale all price indices $P_{i,ntM}$ such that their output-weighted average sums to unity for all sectors.

J.2 Identification steps to derive model-implied variables

Our strategy for identifying amenities, preferences, and productivity builds upon the identification strategies outlined in Caliendo et al. (2018) and Rossi-Hansberg et al. (2019). The identification of model-implied variables from the data takes places in several steps:

1. **Use data on value added, gross output and input-output linkages to derive model-consistent values $\delta_{i,u}$, $\delta_{i,uu'}$, κ_i for all region-sector pairs**

   (a) **Share of value added for all region-sector pairs**

   Expenditures on wages as well as land and structures in region-sector pair {i,u} are a fixed share of total expenditures by equations (31) and (33)

$$\delta_{i,u} = \frac{\sum_{g \in G} w^g_{u|i,u} L^g_{u|i,u} + r_i \mathcal{H}_{i,u}}{\sum_{j \in J} \pi_{ji,u} X_{j,u}}, \tag{39}$$

   such that the parameters $\delta_{i,u}$ can be identified by the fraction of value added over gross regional output in each region-sector pair.

   (b) **Shares of material inputs $\delta_{i,uu'}$ for all regions and sectors**

[34]The computation of the regional real estate price indices follows the methodology outlined in Combes et al. (2019). Ahlfeldt et al. (2020) rely on the micro data-set "Real-Estate Data for Germany", which is described in great detail in Boelmann and Schaffner (2019) and originally comes from the internet platform Immobilien Scout 24. See the Online Appendix of Ahlfeldt et al. (2020) for more details.

Note that in the aggregate economy, total trade flows equal aggregate expenditures, such that

$$\sum_{i\in J}\sum_{j\in J}\pi_{ji,u}X_{j,u}=\sum_{i\in J}X_{i,u}.$$

Summing the demand for materials (34) over all regions yields then

$$\delta_{uu'}=\frac{\sum_{i\in J}M_{i,uu'}P_{i,u'}}{\sum_{i\in J}X_{i,u}},$$

where we define as $\delta_{uu'}$ the share of economy-wide material inputs of goods from sector u' used in the production of goods from sector u. We observe material inputs in the production of goods from each sector from the World Input-Output Tables (Timmer et al. (2015)) at the aggregate level. We, however, cannot observe material inputs by sectors separately for each region. We therefore assume that in all regions, the value of materials $u'\in M$ used as inputs, relative to total material inputs, is constant, such that:

$$\delta_{uu'}=\frac{\delta_{i,uu'}}{\sum_{u'\in M}\delta_{i,uu'}}\quad\forall i\in J.$$

The regional share of material inputs is, therefore, determined as:

$$\delta_{i,uu'}=(1-\delta_{i,u})\,\delta_{uu'}.$$

(c) **Share of value-added accruing to workers** Lastly, we calibrate the share of value added accruing to workers for each region-sector pair as

$$1-\kappa_{i,u}=\frac{\sum_{g\in G}w^g_{u|i,u}L^g_{u|i,u}}{\delta_{i,u}\sum_{j\in J}\pi_{ji,u}X_{j,u}}.\tag{40}$$

2. **Derive expenditures on land and structures and trade imbalances for all regions**

Expenditures on land and structures are a fixed share of total wage expenditures in all region-sector pairs:

$$r_i\mathcal{H}_{i,u}=\frac{\kappa_{i,u}}{1-\kappa_{i,u}}\sum_{g\in G}w^g_{u|i,u}L^g_{u|i,u},\tag{41}$$

such that total (before tax) income of rentiers in region $i\in J$ is given by:

$$\sum_{u\in M}r_i\mathcal{H}_{i,u}=\sum_{u\in M}\frac{\kappa_{i,u}}{1-\kappa_{i,u}}\sum_{g\in G}w^g_{u|i,u}L^g_{u|i,u}.$$

3. **Determine regional shares of national portfolio**

To determine the regional shares of the national portfolio, we match the fiscal budget shares implied by the model Υ_i^M to the observed fiscal budget shares Υ_i^D in the data. We search for the respective shares in the national portfolio that minimize the sum of squared residuals $\sum_{i\in J}\left(\Upsilon_i^M - \Upsilon_i^D\right)^2$ subject to the constraints $\iota_i \in [0,1]$ and $\sum_{i\in J}\iota_i = 1$.

4. **Calculate model-consistent expenditure shares $\beta^C_{u'}$ and $\beta^R_{u'}$ for all sectors**

   Aggregate goods markets clear for all sectors, which, jointly with the definition of $\mathcal{K}$, implies that

$$\begin{aligned}\sum_{i\in J} X_{i,u'} =& \beta^R_{u'}\left(\sum_{i\in J}\sum_{s\in h,u}\sum_{g\in G}\sum_{u\in M}\left(\mathcal{T}_i+\rho_i\right)\left(w^g_{s|i,u}L^g_{s|i,u}\right)+\mathcal{K}\right)\\ &+\beta^C_{u'}\left(\sum_{i\in J}\sum_{s\in h,u}\sum_{g\in G}\sum_{u\in M}\left(1-\mathcal{T}_i\right)w^g_{s|i,u}L^g_{s|i,u}\right)\\ &+\sum_{i\in J}\sum_{u\in M}\frac{\delta_{i,u'u}}{\delta_{i,u}\left(1-\kappa_{i,u}\right)}\sum_{g\in G}w^g_{u|i,u}L^g_{u|i,u},\end{aligned} \tag{42}$$

   Given aggregate wage data, employment data and parameter values for ρ_i and $\mathcal{T}_i$ as well as for $\delta_{i,u}$,$\kappa_{i,u}$ and $\delta_{i,u'u}$ obtained from identification step 1 we solve for model-consistent expenditure shares $\{\beta^C_{u'},\beta^R_{u'}\}$ which imply aggregate sector-specific goods market clearing. We assume that local governments do not consume housing but otherwise distribute expenditures similarly as workers across the remaining sectors. This assumption allows us to fit private expenditures shares better to observable housing expenditures shares in Germany, under the restriction that goods markets still clear in all regions and sectors (42).

5. **Calculate total expenditures on tradables**

   Goods market clearing in all regions and sectors implies that,

$$\begin{aligned}X_{i,u'} =& \beta^R_{u'}\Bigg[\left(\mathcal{T}_i+\rho_i\right)\left(\sum_{s\in h,u}\sum_{u\in M}\sum_{g\in G}w^g_{s|i,u}L^g_{s|i,u}\right)\\ &+\iota_i\left(\sum_{j\in J}\sum_{u\in M}\left(\mathcal{H}_{j,u}r_j-\sum_{g\in G}\left(w^g_{u|j,u}\right)^{1-\rho^g_{h,C}}\xi^g_{h|j,u}L^g_{j,u}\right)\right)\Bigg]\\ &+\beta^C_{u'}\left[\left(1-\mathcal{T}_i\right)\sum_{s\in h,u}\sum_{u\in M}\sum_{g\in G}w^g_{s|i,u}L^g_{s|i,u}\right]+\sum_{u\in M}\delta_{i,u'u}\sum_{j\in J}\pi_{ji,u}X_{j,u},\end{aligned}$$

   which we solve for using the model-consistent expenditure shares $\{\beta^C_{u'},\beta^R_{u'}\}$ from identification step 4.

6. **Calculate relative unit cost shares $\tilde{\lambda}_{i,u}$ for all tradable goods**

   Substituting the expressions for trade shares (36) as well as the calculated values for total expenditure from above into equations (40) yields

$$\sum_{j\in J} X_{j,u} \frac{(\lambda_{i,u}\tau_{ji,u})^{-\nu_u}}{\sum_{n\in J}(\lambda_{n,u}\tau_{jn,u})^{-\nu_u}} = \frac{\sum_{g\in G} w^g_{u|i,u} L^g_{u|i,u}}{\delta_{i,u}(1-\kappa_{i,u})}. \tag{43}$$

For all pairs $\{i,u\}$ we solve for the relative unit costs $\tilde{\lambda}_{i,u} \equiv \frac{(\lambda_{i,u})^{\nu_u}}{\sum_{n\in J}(\lambda_{n,u})^{\nu_u}}$ that are implied by the structure of trade flows. The unit costs can be identified from equations (43) as smaller relative unit costs imply that a region i is the least-cost producer for a larger number of varieties, which increases trade shares towards all regions $j \in J$.

In all sectors where goods are non-tradable, it holds that $\pi_{ji,u} = 0$ as long as $j \neq i$, such that

$$X_{i,nt} = \frac{\sum_{g\in G} w^g_{nt|i,nt} L^g_{nt|i,nt}}{\delta_{i,nt}(1-\kappa_{i,nt})}.$$

where $nt \subset M$ denotes sectors from the subset of market sectors that are non-tradable.

7. **Compute sector-specific price levels for all tradable goods**

Substituting relative unit costs $\tilde{\lambda}_{j,u}$ into price equations (35) allows solving for the ideal region-sector-specific cost indices $P_{i,u}$:

$$P_{i,u} = \Gamma(\gamma_u)^{\frac{1}{1-\sigma}} \left[\sum_{j\in J} \left(\tilde{\lambda}_{j,u}\right)^{-1} (\tau_{ij,u})^{-\nu_u}\right]^{-\frac{1}{\nu_u}} * \left(\sum_{n\in J} (\lambda_{n,u})^{\nu_u}\right)^{\frac{1}{\nu_u}}, \tag{44}$$

where $\sum(\lambda_{n,u})^{\nu_u}$ are sector-specific constants to be determined by normalization. We choose a model-consistent normalization on aggregate sector-specific cost indices: $P_u \equiv \sum_{i\in J} P_{i,u}\pi_{i,u} = 1 \quad \forall u \in TR \subset M$, that is we define sector-specific cost aggregates as a weighted average of region-sector-specific costs and normalize them to unity. The weights $\pi_{i,u} = \frac{X_{i,u}}{\sum_{n\in J} X_{n,u}}$ are the share of total spending in occupation u, that accrues to region-i expenditures. Applying the normalization, we solve for the occupation-specific constants, such that

$$\left(\sum_{n\in J} (\lambda_{n,u})^{\nu_u}\right)^{\frac{1}{\nu_u}} = \frac{1}{\Gamma(\gamma_u)^{\frac{1}{1-\sigma}} \sum_{i\in J} \pi_{i,u} \left[\sum_{j\in J} \left(\tilde{\lambda}_{j,u}\right)^{-1} (\tau_{ij,u})^{-\nu_u}\right]^{-\frac{1}{\nu_u}}}.$$

We subsequently calculate ideal cost indices relative to a weighted average of costs across all regions, that is

$$P_{i,u} = \frac{\left[\sum_{j\in J}\left(\tilde{\lambda}_{j,u}\right)^{-1}(\tau_{ij,u})^{-\nu_u}\right]^{-\frac{1}{\nu_u}}}{\sum_{i\in J}\pi_{i,u}\left[\sum_{j\in J}\left(\tilde{\lambda}_{j,u}\right)^{-1}(\tau_{ij,u})^{-\nu_u}\right]^{-\frac{1}{\nu_u}}}. \tag{45}$$

Using the normalization for aggregate occupation-specific cost indices once again, we solve for unit costs in levels:

$$\lambda_{i,u} = \frac{\left(\tilde{\lambda}_{i,u}\right)^{\frac{1}{\nu_u}}}{\Gamma(\gamma_u)^{\frac{1}{1-\sigma}}\sum_{i\in J}\pi_{i,u}\left[\sum_{j\in J}\left(\tilde{\lambda}_{j,u}\right)^{-1}(\tau_{ij,u})^{-\nu_u}\right]^{-\frac{1}{\nu_u}}}.$$

8. **Compute price levels in all regions for all non-tradable goods**
The price levels of non-tradable services are defined as

$$P_{i,ntS} = \beta_{ntS}\left(\frac{P_{i,S}}{(P_{i,tS}/\beta_{tS})^{\beta_{tS}}}\right)^{\frac{1}{\beta_{ntS}}},$$

where the price level of tradable services $P_{i,tS}$ and the consumption shares of tradable and non-tradable services $\{\beta_{tS}, \beta_{ntS}\}$ follow from the previous steps. In all non-tradable sectors it holds that $\tau_{ij,u} \to \infty$ for all regions $j \neq i$, such that price levels simplify to:

$$P_{i,nt} = \Gamma(\gamma_{nt})^{\frac{1}{1-\sigma}}\lambda_{i,nt}.$$

Using regional price data for our choice of non-tradable sectors, we subsequently solve also for unit costs in these sectors.

9. **Compute productivity as compensating differential to unit costs**
Group-specific labour demand (31) can be re-written in terms of the aggregate wage sum:

$$\frac{w^g_{u|i,u}L^g_{u|i,u}}{\sum_{g\in G}w^g_{u|i,u}L^g_{u|i,u}} = \frac{\left(\frac{T^g_{i,u}}{w^g_{u|i,u}}\right)^{\sigma^g-1}}{\sum_{g\in G}\left(\frac{T^g_{i,u}}{w^g_{u|i,u}}\right)^{\sigma^g-1}}$$

Substituting relative productivity $\tilde{T}^g_{i,u} \equiv \frac{T^g_{i,u}}{\sum_{g\in G}T^g_{i,u}}$ and rearranging terms yields

$$\frac{\left(w^g_{u|i,u}\right)^{\sigma^g}L^g_{u|i,u}}{\sum_{g\in G}w^g_{u|i,u}L^g_{u|i,u}} = \frac{\left(\tilde{T}^g_{i,u}\right)^{\sigma^g-1}}{\sum_{g\in G}\left(\tilde{T}^g_{i,u}\right)^{\sigma^g-1}\left(w^g_{u|i,u}\right)^{1-\sigma^g}}$$

Applying the fact that relative productivity $\tilde{T}^g_{i,u}$ sums to unity in all region-sector pairs by construction allows identifying them solely in terms of observable average wages and market employment:

$$\tilde{T}_{i,u}^{g}=\frac{\left(w_{u|i,u}^{g}\right)^{\frac{\sigma^{g}}{\sigma^{g}-1}}\left(L_{u|i,u}^{g}\right)^{\frac{1}{\sigma^{g}-1}}}{\sum_{g\in G}\left(w_{u|i,u}^{g}\right)^{\frac{\sigma^{g}}{\sigma^{g}-1}}\left(L_{u|i,u}^{g}\right)^{\frac{1}{\sigma^{g}-1}}}$$

Intuitively, relative productivity is larger, given any wage differences, the higher the demand for group-specific employment. The productivity levels can be identified from observable values of aggregate production in all region-sector pairs. From equations (38) as well as group-specific labour demand, demand for land and structures and material demand, we arrive at

$$\sum_{g\in G}\left(T_{i,u}^{g}\right)^{\delta_{i,u}(1-\kappa_{i,u})}=\frac{D_{i,u}}{\lambda_{i,u}}\left(r_{i}^{\kappa_{i,u}}\left[\sum_{g\in G}\left(\frac{\tilde{T}_{i,u}^{g}}{w_{u|i,u}^{g}}\right)^{\sigma^{g}-1}\right]^{\frac{1-\kappa_{i,u}}{1-\sigma^{g}}}\right)^{\delta_{i,u}}\prod_{u'\in M}\left[P_{i,u'}\right]^{\delta_{i,uu'}}$$

Given unit cost estimates, higher local unit prices (e.g. wages, rent, intermediate goods prices) imply a larger regional productivity in sector u:

$$T_{i,u}^{g}=\tilde{T}_{i,u}^{g}\left[\frac{D_{i,u}}{\lambda_{i,u}}\left(r_{i}^{\kappa_{i,u}}\left[\sum_{g\in G}\left(\frac{\tilde{T}_{i,u}^{g}}{w_{u|i,u}^{g}}\right)^{\sigma^{g}-1}\right]^{\frac{1-\kappa_{i,u}}{1-\sigma^{g}}}\right)^{\delta_{i,u}}\prod_{u'\in M}\left[P_{i,u'}\right]^{\delta_{i,uu'}}\right]^{\frac{1}{\delta_{i,u}\left(1-\kappa_{i,u}\right)}}.$$

10. **Compute preferences as compensating differentials to labour supply**
Regional price levels are a Cobb-Douglas aggregate of sector-specific prices by equation (28). Given sector-specific unit cost levels (45), as well as data on wages $w_{u|i,u}^{g}$, tax rates, public expenditure and employment rates, overall amenities $\bar{A}_{i}^{g}\exp\left[-\mu_{u|i,u}^{g}\right]$ are recovered as the residual to observable labour supply:

$$L_{i,u}^{g}=\frac{\left(\bar{V}_{i,u}^{g}\right)^{\theta^{g}}}{\sum_{u\in M}\sum_{i\in J}\left(\bar{V}_{i,u}^{g}\right)^{\theta^{g}}}L^{g},$$

Spatial variation in after-tax real income and public expenditure identifies average group-specific overall amenities up to a group-specific constant for each region-sector pair $\{i,u\}$. Perfect worker mobility across regions and sectors ensures that the worker-group-specific utility levels will be equalized. We, lastly, normalize overall amenities to a group-specific mean of 1 and regress the compound component $\bar{A}_{i}^{g}\exp\left[-\mu_{u|i,u}^{g}\right]$ on region fixed effects for all worker groups to separately identify amenities and region-sector-specific participation costs.

11. **Compute preference shifters for the home market**
We use the structural parameter estimates $\{\epsilon^g, \rho^g_{h,C}, \rho^g_{h,R}, \alpha\}$ and non-employment rates to recover the home-market-specific preference shifters from equations (30):

$$\mathcal{B}^g_{s|i,u} = \left(\xi^g_{h|i,u}\right)^{\frac{1}{\epsilon^g}} \left(\left[w^g_{u|i,u}\right]^{\rho^g_{h,C}}\right)^{1-\alpha} \left(\left[R_{u|i,u}\right]^{\rho^g_{h,R}}\right)^{\alpha}$$

Finally, we split preference shifters into participation costs and home-market-preferences, such that

$$\exp\left[\bar{B}^g_{h|i,u}\right] = \mathcal{B}^g_{s|i,u} \exp\left[-\mu^g_{u|i,u}\right].$$

K Counterfactual appendix

K.1 Procedure

To implement the counterfactual, we hold all parameter values at their initial level in 2008. We then iteratively update the guesses for wages, local rents, prices, and the employment as well as non-employment distribution until in the new counterfactual equilibrium:

1. Wages clear all labour markets and ensure that labour supply (29) equals labour demand; (31)
2. Local rents adjust to clear the market for land and structures;
3. Unit cost adjust to ensure that demand equals supply for all input factors in intermediate production;
4. All goods markets clear;
5. The number of non-employed workers of both genders has endogenously adjusted to fiscal capacity shocks.

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