Spatial Policies and Gender Gaps in Local Labour Supply

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Abstract

This paper analyses how spatial policies affect gender-specific employment patterns across local labour markets. Using quasi-experimental variation from Germany's fiscal transfer system, we find that place-based policies have differential effects on male and female employment, with women showing stronger responses to fiscal changes. These effects vary systematically with local infrastructure: fiscal transfers reduce female and male non-employment in regions with limited childcare access. To explain these patterns, we develop a quantitative spatial framework incorporating group-specific responses to public goods provision and spatial frictions. The analysis reveals that regional redistribution affects labour markets through worker reallocation across space and changes in local employment rates. Combining our empirical estimates with the structural model indicates that optimized redistribution policies would expand female labour force participation and close regional variation in gender gaps, while increasing overall output and welfare.

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

Keywords: Local Public Goods, Taxes, Transfers, Labour Force Participation, Spatial Sorting

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1 Introduction

Regional economic disparities persist in many countries, with notable wage and employment gaps across labour markets. These differences are even larger for some demographic groups, who face unique challenges in workforce participation due to care responsibilities or cultural norms. In Germany, for example, women's non-employment rates are more than twice those of men in high-wage urban areas, while many lower-wage rural regions in the East show nearly equal rates between genders. This variation suggests that local labour market conditions and access to (public) services facilitating labour force participation, such as childcare or commuting infrastructure, shape gender-based employment gaps (Moreno-Maldonado, 2024).

To address regional inequalities, many countries implement place-based policies, including subsidies, infrastructure investments, and fiscal transfers, often focusing on areas with lower incomes or limited public funding. While existing research has examined how these policies affect local wages, productivity, and overall national output, their impact on gaps in labour force participation across demographic groups and locations remains less understood.

In this paper, we investigate how the spatial distribution of resources shapes employment gaps through their impact on both workers' location decisions and barriers to labour market entry. Using quasi-experimental variation to Germany's fiscal transfer system, we first document that place-based policies increase labour force participation in positively treated regions, with particularly strong effects for women. To explain these differential responses, we develop a quantitative spatial model that incorporates group-specific frictions to providing labour alongside traditional externalities such as productivity and fiscal spillovers or congestion effects. Notably, providing local public goods and services impacts location and labour supply decisions but has to be financed by taxing local labour.

In the presence of spatially redistributive policies, the financing and provision of these goods may not take place in the same place, implying a new role for well-designed spatial policies to improve local and aggregate outcomes. We use our framework to derive new theoretical implications for the optimized design of place-based policies, emphasizing the scope for targeting transfers to low-wage areas but also places where barriers to work have left human capital underutilized.

In the theoretical part of this paper, we provide expressions for the taxes, subsidies, and transfers that explicitly internalize this trade-off while maximizing overall welfare. Efficiency requires policy instruments tailored to specific places to internalize the impact of spatial externalities, all the while reducing spatial variation in labour market frictions such as job search costs, childcare constraints, and transportation barriers.[1]

Combining rich labour market, trade and public finance data, we then quantify our model for German labour markets. Implementing optimized fiscal policy, we find sizeable welfare and employment gains, particularly in low-wage areas with high female employment elasticities. Notably, welfare, efficiency, and redistribution gains from optimized spatial policy are significantly larger compared to a framework without frictional labour market frictions (Henkel et al., 2021; Fajgelbaum and Gaubert, 2020, 2024) – highlighting the qualitative and quantitative implications of accounting for the novel labour force participation channel.

Our spatial framework illustrates how local fiscal policy, including the spatial distribution of public services and tax policy, differently affects participation decisions across different demographic groups and heterogeneous locations. For most other ingredients, our quantitative framework builds on recent advances in spatial economics (Redding and Rossi-Hansberg, 2017). Heterogeneous workers derive utility from private (and public) consumption and location-specific amenities while facing idiosyncratic mobility frictions (Allen and Arkolakis, 2014; Diamond, 2016). Firms combine mobile labour and immobile factors to produce traded and non-traded goods (Caliendo et al., 2018), which are used either for private or public goods consumption. Public goods are funded by local income taxes and federal transfers (Henkel et al., 2021; Fajgelbaum et al., 2019). Workers choose locations by comparing real wages, amenities, public goods provisions and local employment probabilities. After location decisions, idiosyncratic "market frictions" determine whether a worker joins the local labour force or becomes non-employed. Employed workers profit more from public goods relative to non-employed individuals but also impose greater congestion on them.[2] Non-employed workers receive a fixed share of local after-tax wages, funded by taxing immobile production factor rents, as non-employment compensation. In our framework, spatial redistribution of funds thus affects local employment via two margins: place-based policies not only influence worker mobility by increasing a location's attractiveness but also address local barriers to employment through improved public services.

[1] These forces and more complex factors are captured in classic models of female labour supply and job search (Cogan, 1981; Mortensen, 2011). Recent applications include Albanesi and Olivetti (2016); Borghorst et al. (2024); Cha and Weeden (2014); Cubas et al. (2019); Erosa et al. (2022); Le Barbanchon et al. (2021).

[2] Non-employed workers impose a lower congestion force on public goods since they do not regularly commute to work (Guglielminetti et al., 2023) or more often privately care for their young children (Brown and Herbst, 2022). These assumptions imply that all else equal demand for public goods, such as public childcare, after-school programs or infrastructure investments, is higher in areas with high employment.

In the presence of spatial externalities, such as agglomeration economies or endogenous amenities, there is scope for public policy to improve on the competitive equilibrium of the spatial economy (Fajgelbaum and Gaubert, 2020, 2024). In our spatial framework, we highlight a further source of inefficiency: spatially-varying market frictions interact with market wages to create place-specific gaps in employment. Public investment into local services such as childcare availability, after-school programs or commuting infrastructure, may, however, alleviate their impact and facilitate the return to the labour force. Spatial redistribution then allows local governments a higher provision in places with high demand and labour elasticities, but small tax revenues.

Our theoretical analysis identifies three important relationships between spatial policy instruments and economic outcomes. First, redistributing resources from high-wage to low-wage areas with higher marginal utility of consumption and lower congestion reduces spatial disparities. However, this redistribution may induce inefficient relocation away from productive centres, reducing both tax revenues (fiscal externality) and overall productivity and output through decreased agglomeration effects (technical externality). Second, while higher taxes on income are necessary to fund public goods, they can distort local labour supply decisions and erode the tax base, particularly in areas where workers already face significant barriers to employment.[3] Third, resource allocation to areas with high labour supply elasticities generates additional fiscal benefits but also increases overall congestion in public goods usage.

To understand these relationships, we derive closed-form expressions for spatial transfers, location-specific income taxes, and wage subsidies that internalize spatial externalities and maximize overall welfare in the economy. These expressions characterize how local economic fundamentals (productivity, amenities and market frictions) interact with spatial externalities in determining efficient resource allocation. Under realistic parameter values, the model generates a distribution of funds that reflects the interaction between local productivity, labour supply responses, and fiscal constraints. Rather than simply transferring resources to the poorest areas, the optimal policy targets both high-employment regions that generate substantial tax revenue and lower-wage areas that show strong potential for expanding labour force participation.

We apply this framework to Germany, which offers pronounced variation in employment rates across regions and demographic groups, along with a comprehensive

[3] See, for example Kleven (2014); Blundell and Shephard (2012); Michaillat and Saez (2019); Moretti (2011); Saez (2002).

fiscal transfer scheme. Our analysis yields three main findings. First, using census revisions as exogenous fiscal shocks, we estimate that place-based transfers affect employment, with the female extensive margin elasticity (0.013) larger than the male elasticity (0.009). Second, combining these estimates with rich labour market, trade and public finance data, we conduct counterfactual analyses that suggest optimized redistribution policies could expand female labour force participation by up to 4.8 percentage points in the most targeted locations and reduce gender employment gaps by 3 percentage points in these targeted areas. Third, at the aggregate level, the model predicts that changing current policies could increase real GDP by 1.7% and enhance welfare by 2.6% through targeting transfers to areas with low wages but large labour force potential.

This paper contributes to recent research on quantitative spatial economics by examining how place-based policies affect both spatial allocation and within-region employment decisions. In standard spatial models in the spirit of Roback (1982), place-based policies may create inefficiencies by incentivizing activity in less productive areas, yet a growing literature identifies localized market failures that can justify spatial targeting. These include spatial externalities, public goods provision, and labour market frictions (Kline and Moretti, 2014).

Our framework builds on this insight by showing how coordinated spatial policies can address market failures through their effects on both localized labour supply decisions and spatial externalities. Our analytical framework nests previous models as special cases while incorporating variable workforce responses and local spillovers. The model indicates that targeting transfers to areas with low wages but high participation elasticities can yield significant welfare gains, extending previous findings about optimal spatial policies (Fajgelbaum and Gaubert, 2024).[4] By introducing regional heterogeneity in market frictions and employment elasticities, we highlight new channels through which place-based transfers can improve efficiency. Spatial policies not only affect the allocation of workers across space but also influence employment decisions within regions through improved public goods provision and reduced local market frictions. This extensive margin response creates additional scope for welfare-improving redistribution beyond the traditional spatial reallocation channel.

Our approach also complements research on persistent unemployment disparities and frictional labour markets (Bilal, 2023; Jung et al., 2023; Kuhn et al., 2021; Schmutz and Sidibé, 2019) by providing a tractable framework for analyzing how

[4] See also Colas and Hutchinson (2021); Donald et al. (2024); Fajgelbaum et al. (2019); Gaubert et al. (2021); Henkel et al. (2021); Rossi-Hansberg et al. (2019) for recent applications.

spatial redistribution affects both the location of economic activity and participation decisions within regions.[5]

Our analysis advances research on gender gaps in labour markets by examining how place-based policies can address constraints that women face in providing labour. A substantial literature documents that gender differences in labour market outcomes stem from several interconnected factors that affect participation decisions. Goldin (2014) shows how the demand for flexible work arrangements disadvantages women who bear greater care responsibilities. Kleven et al. (2019) reveal childbirth's substantial and persistent impact on gender inequality in earnings and employment. These constraints have important spatial dimensions, as documented by Le Barbanchon et al. (2021), who find that women's lower willingness to commute creates systematic differences in job search behaviour and labour market opportunities across locations.

Recent work has emphasized the macroeconomic importance of addressing gender-specific labour market frictions. Hsieh et al. (2019) find that reduced occupational barriers for women contributed significantly to aggregate economic growth, while Albanesi and Olivetti (2016) document how technological and policy changes substantially influence female labour force participation. Building on this research, we quantify the local and aggregate implications of addressing gender-specific frictions through place-based policies. Our theoretical framework captures how place-based policies can improve local infrastructure, services, and incentives to address gender-specific labour market frictions by shifting funds into places with high demand for these services but little funds to finance them. For instance, enhanced local child-care provision can mitigate the child penalties documented in the literature, while improved transportation infrastructure can help overcome commuting constraints.

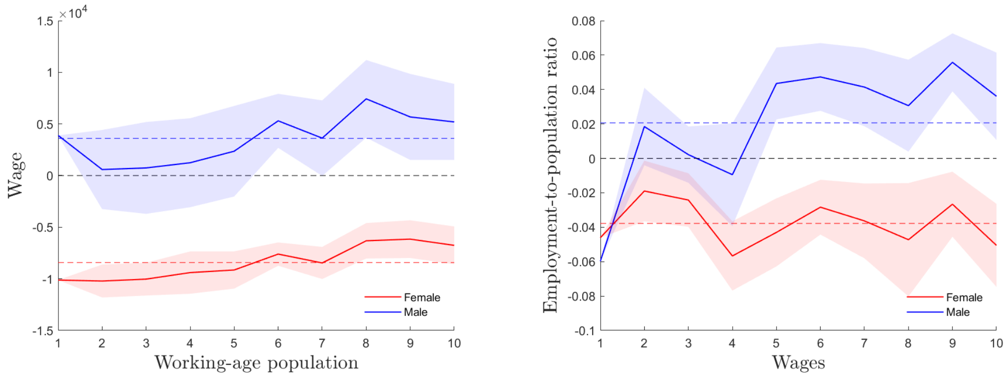
Our empirical analysis reveals that local fiscal shocks have stronger employment effects for women than men. At the same time, counterfactual exercises indicate that alternative redistribution policies could increase female labour force participation and aggregate output and welfare. This integrated approach demonstrates how coordinating local infrastructure, service provision, and tax policies can reduce gender gaps in labour supply while generating substantial economy-wide gains.

[5] While we focus on local spillovers and participation responses, our approach connects to this work by showing how extensive labour supply margins can be represented as the long-run equilibrium in search-and-matching models with frictional labour markets (Kline and Moretti, 2013).

2 Stylized Facts

This section examines Germany's economic disparities across locations and the fiscal redistribution scheme that motivates our quantitative analysis.

Our study analyses local labour market areas or commuting zones (CZs) between 2008 and 2018. We focus on their employment-to-population ratio, termed the labour force participation rate (LFP), which inversely relates to non-employment. Non-employed workers encompass all working-age individuals not currently employed, including those seeking work, in job training, on leave, or searching without official unemployment registration. We use the SIAB dataset and EU KLEMS Database to construct gender-specific wage measures by region, applying an AKM earnings model (Abowd et al., 1999) on individual wages and addressing wage censoring with imputation methods.



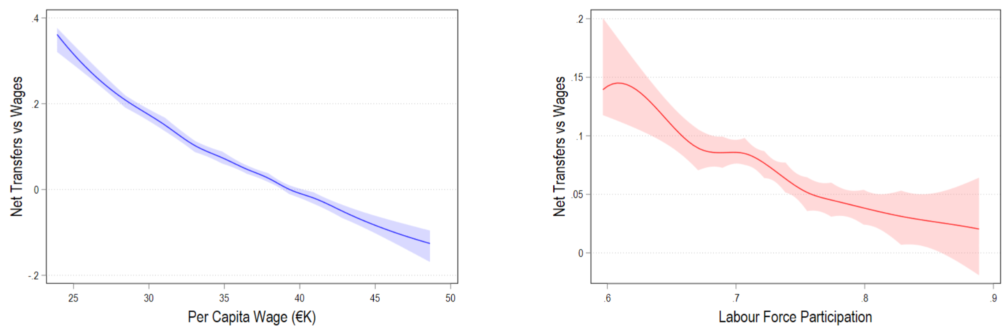
(a) Urban wage premium w/o Controls (b) LFP vs Wages w/o Controls

Figure 1: Urban Premia and Gender Gaps

Notes: This figure shows the relationship between cross-sectionally demeaned wages (Panel (a)) and LFP rates (Panel (b)) against labour market size and wage deciles for males and females in Germany, 2008 – 2018. LFP rates are defined as local labour supply relative to the working-age population. The dotted lines represent the mean across all commuting zones (CZs). Two solid lines are plotted, one for each gender, representing the demeaned average of each variable within each bin. The shaded areas around each line represent the 95% confidence interval. While larger labour markets generally have higher wages, this does not necessarily translate into higher female LFP rates.

In Figure 1, we analyze how labour force participation and wages vary across German labour markets. We divide these markets into population or wage deciles and document two distinct patterns. Larger cities exhibit higher wages (Panel a), consistent with the well-documented urban wage premium (Glaeser and Maré, 2001; Combes et al., 2008; Baum-Snow and Pavan, 2012; Roca and Puga, 2017). However, these higher wages affect labour force participation differently across gender groups

(Panel b). While men's labour force participation rates peak in large, dense labour markets where wages are highest (Dauth et al., 2022; Papageorgiou, 2022), women's participation shows a different pattern. Gender gaps in labour force participation are most pronounced in populous, high-wage regions. This pattern is particularly evident in West German cities, where women's non-employment rates can be more than twice those of men, while rural areas in East Germany show nearly equal participation rates across genders. These patterns reflect the influence of local labour market conditions, including access to childcare, transportation infrastructure, job search frictions, and skill-job mismatches. Similar variations exist in the United States, especially among young mothers (Moreno-Maldonado, 2024).



(a) Net Transfers vs Wages w/ Controls (b) Net Transfers vs LFP w/ Controls

Figure 2: Stylised Facts about the German Fiscal Redistribution Scheme

Notes: This figure illustrates the relationship between net transfers (relative to wages) and the local labour force participation rate. It uses a nonlinear binned scatter plot with 10 bins, controlling for (i) the local working-age population and (ii) other local labour market characteristics (wages or labour force participation rates). The plot accounts for year-fixed effects and clusters standard errors by commuting zone (CZ). The shaded areas represent 95% confidence intervals based on 50,000 random draws.

Germany operates a comprehensive fiscal redistribution system that transfers nearly 10% of nominal GDP between different government layers and regions. This system follows a formula-based approach where transfers depend on a region's fiscal capacity (determined by local tax bases and revenue) and its assessed fiscal needs, primarily driven by population size. The system aims to equalize living conditions across regions by reallocating funds towards less affluent areas (Henkel et al., 2021).

Figure 2 examines two relationships in this redistribution system. For each relationship, we control for the other factor and the working-age population to isolate its unique association with transfers. Panel (a) demonstrates that wages are a key predictor of transfer patterns, with funds flowing from high-wage to low-wage cities, consistent with the system's design and theoretical predictions (Fajgelbaum and Gaubert, 2020, 2024; Henkel et al., 2021). Panel (b) shows that regions with lower labour force participation rates receive higher per capita transfers. This latter pattern reflects that some states' equalization formulas explicitly account for local non-employment rates.

These place-based policies affect where people live and work. Redistributed funds support public amenities that increase local attractiveness (Tiebout, 1956) and help workers, especially women, join the labour force. In Section 3, we develop a theoretical framework capturing these dual effects of spatial redistribution. Section 4 then explores optimal fiscal policy that both enhances labour market participation and reduces disparities in economic outcomes, all while aiming to increase overall efficiency and welfare. In Section 5, we provide further evidence of how the redistribution of funds across regions influences spatial variation in (female) labour supply: exploiting exogenous shocks to the German fiscal redistribution system, we estimate the impact of fiscal transfers on local LFP rates. The effects on treated regions are sizeable, statistically significant, and larger for female workers. In Section 6, we run counterfactual scenarios to estimate the general equilibrium effects of implementing optimized spatial policy. Section 7 concludes.

3 Theoretical Framework

This section presents our theoretical framework for analysing how spatial policies affect both the geographic distribution of economic activity and labour force participation. Building on recent advances in spatial economics (Redding and Rossi-Hansberg, 2017), we develop a model that captures how local fiscal policies influence workers' decisions about where to live and whether to work, allowing us to examine the efficiency implications of spatial redistribution. Refer to Section A in our Online Supplement for detailed derivations.

3.1 Setup

The economy comprises $i \in J$ regions connected by trade and populated by L heterogeneous individuals who can move freely between locations. Workers belong to different demographic groups $g \in G$ (e.g., men and women), and differ in their valuation for different locations and market employment. They make sequential decisions about where to live and whether to participate in market employment m

or join the home sector h, as illustrated in Figure 3. After choosing locations based on wages, amenities, and public services, workers learn about local labour market frictions that influence their participation decision.

Workers draw preference for locations	Workers choose work and residence location	Individual-specific local market frictions are revealed	Workers decide to stay in labour force or not	Workers join home sector h if it offers higher utility

Figure 3: Timing of Events

The economic environment is shaped by three key components:

Preferences. Each individual ω of group g in location i and sector $s \in (h, m)$ derives utility from private goods $C^g_{s|i}$ and public services $R_{s|i}$:

$$U^g_{s|i}(\omega) = a^g_i(\omega)\left[\left(C^g_{s|i}\right)^{1-\alpha} \cdot \left(R_{s|i}/L^\chi_i\right)^\alpha\right] \cdot b^g_{s|i}(\omega), \tag{1}$$

where $0 < \alpha < 1$ governs the preference for each type of good. Location preferences $a^g_i(\omega)$ follow a Fréchet distribution with shape parameter $\theta > 1$: $F^g_i(a) = \exp(-A^g_i \cdot a^{-\theta})$, and with $A^g_i = \bar{A}^g_i L^{-\eta}_i$ a fundamental amenity term. Amenities consist of an exogenous part $\bar{A}^g_i$, which is shifted endogenously by local population $L_i = \sum_{g\in G} L^g_i$ with constant elasticity $-\eta < 0$ (Allen and Arkolakis, 2014; Diamond, 2016). After choosing a location i, a second shock determines workers' extensive labour supply. This shock governs the impact of local market frictions on individual utility and differs by workers' employment status:

$$b^g_{s|i}(\omega) = \begin{cases} 1 & \text{if } s = m, \\ \exp\left[B^g_{h|i}\right]\varphi(\omega) & \text{otherwise.} \end{cases} \tag{2}$$

Here, $\exp\left[B^g_{h|i}\right]\varphi(\omega) > 1$ is a market friction term capturing the cost of joining the labour force in terms of utility units. The market friction term is divided into an exogenous component $\exp\left[B^g_{h|i}\right]$ and an idiosyncratic component $\varphi(\omega) > 1$, which is drawn from a Pareto distribution $Q^g(\varphi) = 1 - \varphi^{-\epsilon^g}$ and with shape parameter $\epsilon^g > 1$. Public goods access varies by employment status according to:

$$\frac{R_{s|i}}{L^\chi_i} = \begin{cases} R_i/L^\chi_i & \text{if } s = m, \\ (R_i/L^\chi_i)^{1-\rho^g_h} & \text{otherwise,} \end{cases} \tag{3}$$

where $0 < \rho_h^g < 1$, and the parameter $\chi \in [0, 1]$ governs the extent of the rivalry of public goods consumption. Employed workers benefit more from these services but also generate greater congestion.

Production. The production structure features regional specialization and trade following Caliendo et al. (2018). Firms combine labour l_i and immobile factors h_i (fixed land and structures) under perfect competition, with production function

$$y_i(z_i) = z_i h_i^{\kappa_i} (Z_i l_i)^{1-\kappa_i}, \tag{4}$$

where z_i represents firm-specific productivity for each variety drawn from a Fréchet distribution, and $1-\kappa_i$ the labour share in production. [6] The cumulative distribution function is given by $\phi_i(z) = \exp\{-z^{-\nu}\}$, where the shape parameter $\nu > 1$ governs the variance of efficiency draws. Labour input combines different worker types with elasticity of substitution $\sigma^g > 1$:

$$l_i = \left[\sum_{g \in G} \left(Z_i^g (1 - \xi_{h|i}^g) L_i^g\right)^{\frac{\sigma^g - 1}{\sigma^g}}\right]^{\frac{\sigma^g}{\sigma^g - 1}} \tag{5}$$

Here $\xi_{h|j}^g \equiv L_{h|i}^g / L_i^g$ represents the local non-employment share. Similarly, $\xi_{m|i}^g \equiv L_{m|i}^g / L_i^g = 1 - L_{h|i}^g / L_i^g$. Average labour productivity $Z_i^g = \bar{Z}_i^g \left(\sum_{g \in G} (1 - \xi_{h|i}^g) L_i^g\right)^{\zeta^g}$ includes both an exogenous component and agglomeration economies that increase with local employment under constant group-specific elasticity $\zeta^g > 0$. The cost of inputs $\lambda_i(z_i)$ is determined as

$$\lambda_i(z_i) = \frac{D_i}{z_i} \left(r_i^{\kappa_i} \left[\sum_{g \in G} \left(\frac{Z_i^g}{w_i^g}\right)^{\sigma^g - 1}\right]^{\frac{1-\kappa_i}{1-\sigma^g}} \right), \tag{6}$$

where $D_i \equiv \kappa_i^{-\kappa_i} (1 - \kappa_i)^{-(1-\kappa_i)}$ and λ_i is the unit cost index as a function of wages w_i^g and rents r_i. Trade flows between regions follow an Eaton-Kortum structure (Eaton and Kortum, 2002) with iceberg costs τ_{ij}. The share of total expenditures in region i from region j is

$$\pi_{ij} = \frac{X_{ij}}{X_i} = \frac{(\lambda_j \tau_{ij})^{-\nu}}{\sum_{n \in J} (\lambda_n \tau_{in})^{-\nu}} \tag{7}$$

[6] We assume the supply of local land and structure, denoted by H_i, is exogenous and inelastic.

where X_{ij} represents expenditure in region i on goods produced in region j, and $X_i = Y_i P_i$ is gross output in i. Final goods producers source intermediate goods from locations offering the lowest acquisition cost and combine them using a CES technology with a substitution elasticity $\sigma > 1$. This leads to regional price indices:

$$P_i = \Gamma\left(\frac{\nu + 1 - \sigma}{\nu}\right)^{\frac{1}{1-\sigma}} \left[\sum_{j \in J} (\lambda_j \tau_{ij})^{-\nu}\right]^{-\frac{1}{\nu}}, \tag{8}$$

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

The resulting final goods serve both private consumption and public provision. Total expenditure in each region, $X_i \equiv P_i Y_i = P_i C_i + P_i^R R_i$, comprises private consumption $P_i C_i \equiv P_i \sum_{s \in h,m} \sum_{g \in G} \xi_{s|i}^g C_{s|i}^g$, and government spending $P_i^R R_i \equiv E_i$, where P_i^R denotes the price level of local governments.

Public Finance. The public finance system follows Germany's institutional setting, with both federal and local components. Workers receive after-tax income $I_{s|i}^g = (1 - t_{s|i}) w_i^g + x_{s|i}^g$, combining wages taxed at a rate $t_{s|i}$ with lump-sum subsidies $x_{s|i}^g$ from a national portfolio. The nationwide portfolio $\mathcal{K}$ aggregates rents from immobile production factors across all regions and funds non-employment compensation $(1 - t_{h|i}) \xi_{h|i}^g w_i^g L_i^g$ in all locations: $\mathcal{K} = \sum_{j \in J} \left(r_j h_j - (1 - t_{h|j}) \sum_{g \in G} \xi_{h|j}^g w_j^g L_j^g \right)$, where $r_i h_i$ denote local rents from the immobile production factor in region i.[7] All workers receive equal portfolio dividends: $x_{s|i}^g = x = \mathcal{K}/L \quad \forall g, i, s$.

Local governments provide public services funded by income taxes and federal transfers (Fajgelbaum et al., 2019; Henkel et al., 2021). The federal government redistributes part of the income tax revenue across locations using transfer rates ι_i, leading to local government expenditure:

$$E_i = (t_{m|i} + \iota_i) \sum_{g \in G} (1 - \xi_{h|i}^g) w_i^g L_i^g. \tag{9}$$

3.2 Labour Force Participation and Spatial Sorting

After choosing locations, workers learn about the total size of idiosyncratic market frictions and decide whether to remain in the labour force. Workers join the home market sector h if the achievable indirect utility exceeds that in the market sector m. Using the properties of Pareto distributions, the number of workers choosing

[7] Non-employed workers receive a fraction of after-tax labour income as non-employment compensation, implying that workers in the home market sector h pay higher taxes $t_{h|i} > t_{m|i}$.

non-employment in region i follows as

$$L_{h|i}^{g}=\xi_{h|i}^{g}L_{i}^{g}=\Bigg[\underbrace{\left(\exp\left[B_{h|i}^{g}\right]\right)^{-1}}_{\text{Market Frictions}}\underbrace{\left(\frac{I_{m|i}^{g}}{I_{h|i}^{g}}\right)^{1-\alpha}\left(\left[\frac{R_i}{L_i^{X}}\right]^{\rho_h^g}\right)^{\alpha}}_{\text{Spatial Policies}}\Bigg]^{-\epsilon^g}L_i^g. \tag{10}$$

This equation reveals how spatial policies influence labour supply through three channels. First, higher after-tax wages relative to non-employment compensation encourage market participation. Second, public goods access affects employment decisions, with an elasticity $\gamma^g \equiv \alpha\epsilon^g\rho_h^g$ that we estimate empirically in section 5. Third, local market frictions $\exp\left[B_{h|i}^{g}\right]$ create barriers to employment that policies can help overcome. Participation decisions generate spillovers on other workers through its impact on local budgets as well as congestion and agglomeration effects.

Notably, our framework's labour supply equation can alternatively be derived as the steady state of a search-and-matching model with regional unemployment (Kline and Moretti, 2013), providing micro-foundations for the labour supply elasticity and market frictions in equation (10) (see Online Supplement A.3 for derivations and discussions).

Workers choose locations to maximise expected utility, accounting for both employment prospects, real incomes and local amenities. This yields the condition for regional labour supply in spatial equilibrium:

$$L_i^g=\frac{(\bar{V}_i^g)^{\theta}}{\sum_{i\in J}(\bar{V}_i^g)^{\theta}}L^g. \tag{11}$$

where $\bar{V}_i^g$ represents indirect utility incorporating the weighted utility of becoming employed or non-employed.[8]

3.3 Equilibrium

A competitive equilibrium in this economy consists of prices, allocations, and government policies that satisfy all optimization conditions and market clearing constraints.

[8]Combining equations (1) and (10) and using $C_{s|i}^{g}=I_{s|i}^{g}/P_i$ with the the Pareto distribution properties, we derive the expected indirect utility of workers as

$$\bar{V}_i^g(\omega)=a_i^g(\omega)\sum_{s\in h,m}V_{s|i}^{g}\xi_{s|i}^{g}=a_i^g(\omega)\,\bar{V}_{m|i}^{g}\left(1+\xi_{h|i}^{g}/(\epsilon^g-1)\right)\equiv a_i^g(\omega)\,\bar{V}_i^g,$$

where $\bar{V}_{m|i}^{g}=A_i^g\left[\left(I_{m|i}^{g}/P_i\right)^{1-\alpha}\cdot(R_i/L_i^{X})^{\alpha}\right]$ is the average indirect utility when employed.

Definition 1. *Given exogenous characteristics* $\{\bar{A}_i^g, B_{h|i}^g, H_i, \bar{Z}_i^g\}$*, the total number of workers of each type* L^g*, a set of spatial policies* $\{t_{s|i}, x_{s|i}^g, \iota_i\}$*, and structural parameters* $\{\alpha, \epsilon^g, \zeta^g, \theta, \kappa_i, \nu, \rho_h^g, \sigma, \sigma^g, \tau_{ij}, \chi\}$*, a competitive equilibrium for this economy is defined by the set of endogenous objects* $\{E_i, h_i, I_{s|i}^g, L_i^g, L_{s|i}^g, P_i, r_i, w_i^g, X_i, \lambda_i, \pi_{ij}\}$ *such that:*

1. *Workers optimize location and employment choices given regional wages, amenities, and public services*
2. *Firms maximize profits given production costs and trade opportunities*
3. *Local governments maintain balanced budgets while providing public services*
4. *All goods and factor markets clear in each region*

Detailed derivations of market clearing conditions and equilibrium properties are provided in our Online Supplement A.2. The next section examines how a benevolent social planner would design spatial policies in this environment, highlighting key trade-offs between efficiency and redistribution objectives.

4 Optimal Spatial Policy

This section analyses how spatial policies affect economic outcomes within our theoretical framework. We characterize key relationships between policy instruments and equilibrium allocations and quantify their implications for economic aggregates in Section 6.

4.1 Social Planner Problem

We analyze the problem of a utilitarian planner maximizing social welfare in the quantitative framework discussed in the previous section. The planner faces constraints in three dimensions: local demand must equal supply for final goods, intermediate goods production must meet demand across locations, and factor markets must clear given worker mobility and participation decisions. The welfare function is

$$\mathcal{W} = \sum_{g \in G} \mu^g \mathcal{U} \left[\Gamma\left(\frac{\theta - 1}{\theta}\right) \left(\sum_{i \in J} \left[\bar{V}_i^g\right]^\theta \right)^{\frac{1}{\theta}} L^g \right], \tag{12}$$

where μ^g are welfare weights for each group and $\mathcal{U}(.)$ is an increasing and concave function of workers' utility.

Several factors cause the competitive equilibrium to deviate from the planning solution. Workers' location choices affect productivity through agglomeration effects, their labour supply decisions influence tax revenues, and their consumption patterns impact public goods congestion. These mechanisms create scope for policy to affect allocations through three channels: Redistribution between locations affects consumption and congestion. Tax rates influence labour supply and fiscal revenues. Public goods provision generates local labour supply gains but has to be financed by higher taxation. The planner's solution characterizes how these channels interact to determine equilibrium outcomes. For the set-up and detailed derivations of the planner's problem, please see Appendix A.

4.2 Efficiency and Optimal Spatial Policies

The efficient allocation equates the marginal costs and benefits of allocating workers across locations and labour market statuses. Proposition 1 formalizes this condition:

Proposition 1. *The competitive allocation of labour is efficient if the planner's problem exhibits global concavity and satisfies:*

$$\underbrace{W_i^g}_{\text{opportunity cost}} + \underbrace{P_i \sum_{s \in h,m} \xi_{s|i}^g C_{s|i}^g}_{\text{consumption cost}} = \underbrace{\left(1 - \xi_{h|i}^g\right) w_i^g}_{\text{marginal product of labour}} + \underbrace{Ex_i^{NET}}_{\text{net spatial externalities}} \tag{13}$$

Proof. See Appendix A.2.

The left-hand side captures the total cost of adding a worker to location i: their opportunity cost in i relative to location in other places (W_i^g) plus consumption cost. The right-hand side represents the benefits: the worker's marginal product plus net spatial externalities (Ex_i^{NET}). These net externalities comprise:

$$\text{Ex}_i^{\text{NET}} \equiv \underbrace{\text{Ex}_i^{\text{AGG}}}_{\text{productivity spillovers}} - \underbrace{\text{Ex}_i^{\text{CON}}}_{\text{congestion spillovers}} - \underbrace{\text{Ex}_i^{\text{LFP}}}_{\text{spillovers on local labour force}}$$

where

$$\text{Ex}_i^{\text{AGG}} = \zeta^g \left(1 - \xi_{h|i}^g\right) w_i^g \tag{14}$$

$$\text{Ex}_i^{\text{CON}} = \frac{\chi(\alpha - \Upsilon_i^g) + \eta}{(1-\alpha)} \cdot \bar{\mathcal{C}} \tag{15}$$

$$\text{Ex}_i^{\text{LFP}} = \chi \gamma^g (\xi_{h|i}^g) w_i^g \tag{16}$$

Here, $\Upsilon_i^g \equiv \frac{\gamma^g \xi_{h|i}^g}{\epsilon^g - (1-\xi_{h|i}^g)}$ is a decreasing function of local labour force participation, while $\bar{\mathcal{C}} = \sum_{i \in J} P_i \sum_{s \in h,m} \sum_{g \in G} \xi_{s|i}^g C_{s|i}^g L_i^g / L$ is average private goods expenditure.

These externalities interact in three key ways. First, productivity spillovers increase the marginal product of labour through agglomeration effects as more workers join the local labour force (Combes and Gobillon, 2015; Rosenthal and Strange, 2004). Second, congestion effects reduce amenity values (when $-\eta < 0$) and public goods availability, particularly when consumption is rival ($\chi > 0$) or local participation rates are high. Third, these congestion effects influence local labour supply decisions through equation (10), with stronger impacts in locations facing significant market frictions.

Our framework extends the efficiency conditions of Fajgelbaum and Gaubert (2020) by introducing frictional non-employment, which creates additional compensating differentials and new policy channels. When workers join the local labour force, they generate positive spillovers by expanding the resources available for consumption.

Spatial externalities interact with local labour markets through heterogeneous labour supply elasticities that vary with market frictions. This spatial heterogeneity provides another rationale for location-specific policies, departing from previous work assuming spatially uniform spillovers, which then do not require policies to tag different places specifically (Fajgelbaum and Gaubert, 2024). This interconnection between spatial externalities and local labour market frictions has important implications for policy design, which we discuss in the subsection below.

Within the model's framework, the distribution of resources depends on regional differences in spatial externalities. All else equal, resources should flow toward locations where net spatial externalities exceed the national average, measured as $dEx_i^{NET} \equiv \left(Ex_i^{NET} - \sum_{j \in J} Ex_j^{NET} L_j^g / L^g \right)$. However, the magnitude and direction of these flows must also account for how local labour supply elasticities shape policy effectiveness.

4.3 Optimal Policy Tools

The planner can affect allocations through three policy instruments: income tax rates, wage subsidies and transfers to local governments, $\{\tilde{t}_{s|i}^g, \tilde{x}_{s|i}, \tilde{E}_i\}$.[9] Proposition 2 characterizes how these instruments interact:

[9] We first present insights using a simplified version with a single market sector (M=1) and group (G=1) to highlight the essential mechanisms, with complete derivations for the full model available in the Online Supplement.

Proposition 2. *When $G = M = 1$, the following conditions describe the relationship between policy instruments (income taxes $\tilde{t}_{s|i}$, wage subsidies $\tilde{x}_{s|i}$, and local government transfers $\tilde{E}_i$) and socially optimal allocations:*

1. *Private consumption levels are determined by after-tax income and subsidies:*

$$P_i\tilde{C}_{s|i} = \left(1 - \tilde{t}_{s|i}\right) w_i + \tilde{x}_{s|i} \tag{17}$$

2. *Local government budgets are funded by local tax revenue and fiscal transfers:*

$$\tilde{E}_i = \left(\tilde{t}_i^R + \tilde{\iota}_i\right)(1 - \xi_{h|i})w_iL_i \tag{18}$$

3. *Tax rates are differentiated between employed (m) and non-employed workers:*

$$1 - \tilde{t}_{s|i} = \begin{cases} \frac{(1-\alpha)\theta}{1+(1-\alpha)\theta} + (1-\alpha)\epsilon\xi_{h|i}\left(\frac{1}{1-\xi_{h|i}} - \frac{\theta}{(1+(1-\alpha)\theta)\left(\epsilon-(1-\xi_{h|i})\right)}\right) & \text{if } s = m, \\ \frac{1-\xi_{h|i}}{\xi_{h|i}}\left(\frac{(1-\alpha)\theta}{1+(1-\alpha)\theta} - (1 - \tilde{t}_{m|i})\right) & \text{otherwise} \end{cases}$$

4. *Wage subsidies account for local externalities:*

$$\tilde{x}_{s|i} = \begin{cases} \frac{\epsilon-1}{\epsilon-(1-\xi_{h|i})}\left[\sum_j \left(\frac{(1-\xi_{h|j})w_jL_j}{1+(1-\alpha)\theta} + r_jh_j - \tilde{E}_j\right)/L + \frac{(1-\alpha)\theta L\cdot dEx_i^{NET}}{1+(1-\alpha)\theta}\right] & \text{if } s = m, \\ \frac{\epsilon}{\epsilon-1}\cdot\tilde{x}_{m|i} & \text{otherwise} \end{cases}$$

5. *Fiscal redistribution incorporates local labour market conditions:*

$$\tilde{t}_i^R = \frac{(\alpha - \Upsilon_i)\,\theta}{1 + \xi_{h|i}(1-\alpha)\theta}\sum_{s\in h,m}\xi_{s|i}\tilde{t}_{s|i}\ ; \quad \tilde{\iota}_i = \frac{\gamma\xi_{h|i}}{1-\xi_{h|i}} + \frac{(\alpha - \Upsilon_i)}{1-\alpha}\frac{\epsilon - (1-\xi_{h|i})}{\epsilon - 1}\frac{\tilde{x}_{m|i}}{(1-\xi_{h|i})w_i}$$

Proof. See Appendix A.3 and our Online Supplement for detailed calculations.

The next two subsections provide intuition for these results by examining how they shape optimal income taxation and fiscal redistribution across locations. We show how these instruments work together to address local labour market conditions while maintaining efficiency in the broader economy.

4.3.1 Optimal Income Taxation

The optimal tax policy varies significantly depending on whether labour markets exhibit frictions. We analyse two key scenarios:

1. Without Frictional Non-Employment. In the absence of frictions ($\epsilon \to \infty$ and $\xi_{h|i} = 0$), the planner implements a uniform tax rate across regions: $t_{m|i} = t_i = [1 + (1 - \alpha)\theta]^{-1}$. This uniformity reflects a fundamental principle: varying tax rates across locations would create inefficient migration incentives unrelated to productivity differences (Fajgelbaum et al., 2019; Fajgelbaum and Gaubert, 2024; Helpman and Pines, 1980; Wildasin, 1987). The optimal tax rate decreases with regional worker mobility and private goods preferences, consistent with public finance principles that favour taxing less elastic factors (Keen and Konrad, 2013).

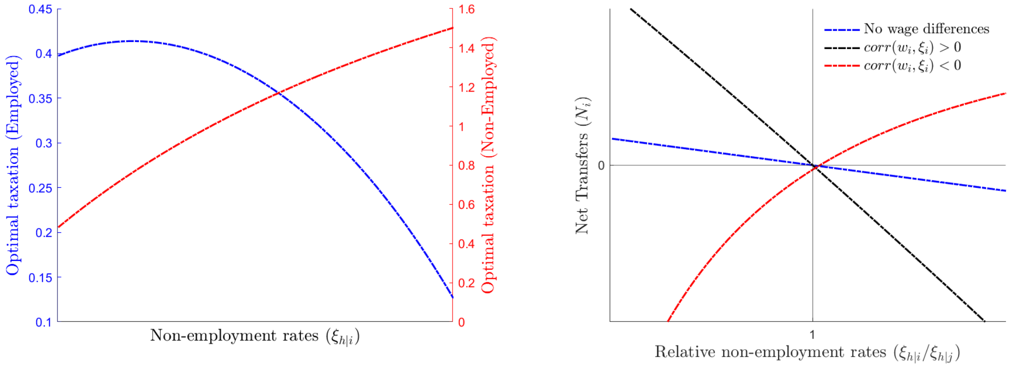
2. With Frictional Non-Employment. Introducing labour market frictions ($\epsilon < \infty$ and $\xi_{h|i} > 0$) fundamentally changes optimal taxation. The planner now implements location-specific tax rates to account for heterogeneous labour supply elasticities. This creates a crucial trade-off: higher tax rates in low-participation areas could maintain tax revenue but further depress local labour force participation through equation (10).

Our simulations in Panel (a) of Figure 4 reveal that, under realistic parametrization, optimal tax rates for employed workers follow a U-shaped relationship with non-employment rates. Starting from the frictionless rate ($t_i = [1 + (1 - \alpha)\theta]^{-1}$), taxes initially rise with non-employment to maintain revenue but eventually decline when market frictions become severe enough to warrant expanding the tax base. Simultaneously, tax rates on non-employed workers increase more sharply in low-participation areas to incentivize employment.

4.3.2 Net Fiscal Transfers and Optimal Redistribution

The optimal redistribution pattern emerges from comparing fiscal policies before and after implementing optimal policies. We start from a baseline without redistribution where non-employed workers receive $(1 - t_{m|i})(1 - o)w_i$ as compensation from immobile factor rents, and local taxes fund public goods: $E_i^{before} = t_{m|i}(1 - \xi_{h|i})w_i L_i$. Any remaining rents are redistributed to local workers as lump-sum subsidies. Then, we allow the planner to implement the optimized policies from Proposition 2. Among others, they determine the optimal consumption of private and public goods. We define the corresponding change in private consumption expenditures as $dP_iC_{s|i} \equiv (P_iC_{s|i})^{after} - (P_iC_{s|i})^{before}$, and dE_i similarly as the change in public goods expenditure.

Definition 2. *Net fiscal transfers N_i measure changes in private and public good*



(a) Optimal tax rates (b) Optimal redistribution

Figure 4: Optimal Spatial Policies

Notes: These figures plot the optimal tax rates and net transfers against different levels of non-employment rates for two locations i, j, using equation (20) and parameter values used in the quantification for Germany ($\alpha = 0.24$; $\epsilon = 1.55$; $\theta = 2$; $1-\gamma = 0.62$; $\kappa = 0.34$; $\zeta = 0.02$; $\rho_h = 0.012$; $\chi = 1$. Panel (a) displays optimal tax rates for workers of different employment statuses as a function of non-employment rates, $\xi_{h|i}$, while Panel (b) plots net transfers against relative non-employment rates, $\xi_{h|i}/\xi_{h|j}$, between places. For Panel (b), we distinguish three scenarios: (a) no wage differences, $w_i = w_j$, (b) $corr(w_i, \xi_{h|i} > 0)$, where low-wage locations feature high labour force participation rates relative to the other region and (c) $corr(w_i, \xi_{h|i} < 0)$, where high-wage locations feature high relative labour force participation rates.

consumption possibilities per capita after redistribution:

$$N_i = \sum_{s \in h,m} \xi_{s|i} dP_i C_{s|i} + d(E_i/L_i). \tag{19}$$

Corollary 1 characterizes how these transfers depend on local market conditions through five key components: relative market compensation, non-market compensation, non-employment rates, average non-market compensation, and an extended Samuelson rule for public goods provision.

Corollary 1. *Suppose each location has a unique labour force participation rate, and no funds are redistributed across locations initially. Net fiscal transfers i are the difference in consumption possibilities with and without redistribution. They are* *given by:*

$$N_i = \Theta_{i,1} \underbrace{\left(\sum_{j \in J} w_j L_j / L - w_i \right)}_{\text{relative market compensation}} + \Theta_{i,2} \underbrace{\left(\sum_{j \in J} \xi_{h|j} w_j L_j / L - \xi_{h|i} w_i \right)}_{\text{relative non-market compensation}} \tag{20}$$
$$- \Theta_{i,3} \underbrace{\left(\sum_{j \in J} \Upsilon_j L_j / L - \Upsilon_i \right)}_{\text{relative non-employment rates}} + \underbrace{\gamma \sum_{j \in J} \xi_{h|j} w_j L_j / L}_{\text{average non-market compensation}}$$
$$+ \frac{1}{(1-\alpha)L} \underbrace{\left[(1 - \Upsilon_i/\alpha) \sum_{j \in J} \alpha \left((1 - \xi_{h|j}) w_j L_j + r_j h_j \right) - (1 - \Upsilon_i) \sum_{j \in J} \tilde{E}_j \right]}_{\text{extended "Samuelson rule"}}$$

where

$$\Theta_{i,1} \equiv \frac{1 - \left[\alpha (1 - \Upsilon_i/\alpha) + \zeta (1 - \Upsilon_i) \right] \theta}{1 + (1-\alpha)\theta}$$
$$\Theta_{i,2} \equiv -\Theta_{i,1} - \gamma \left(1 - \frac{\left[1 - \Upsilon_i \right] \theta \chi}{1 + (1-\alpha)\theta} \right) + (1 - o)(1 - t_{m|i})$$
$$\Theta_{i,3} \equiv \frac{\chi \left[1 - \Upsilon_i \right] \theta \cdot \bar{\mathcal{C}}}{\left[1 + (1-\alpha)\theta \right] (1-\alpha)}$$

Proof. Combining the optimal fiscal policies from Proposition 2 with the definition of net fiscal transfers, Corollary 1 immediately follows.

The optimal redistribution pattern varies with labour market conditions:

1. Without Frictional Non-Employment. Without frictions, redistribution flows from high-wage to low-wage areas following the relative market compensation term and Samuelson's rule for public goods (Samuelson, 1954).[10] The planner has an incentive to redistribute to low-wage areas as workers in these regions benefit more from additional consumption, particularly if they have high amenity values for these locations. However, this redistribution creates two key inefficiencies: First, as workers relocate to low-wage, low-productivity regions, tax revenues and government budgets decrease (fiscal externality). Second, this relocation reduces overall productivity and output (technical externality), with stronger effects when agglomeration externalities (ζ) are larger. The planner continues redistributing to below-average-

[10] The Samuelson rule suggests that optimal public spending is determined by weighing the marginal social benefits and costs of provision. Given Cob-Douglas preferences, this implies that a fraction α of total value added should be provided as public goods. Any remaining difference will be distributed as a lump sum across all workers.

income locations as long as the marginal utility gains exceed these efficiency costs, which occurs as long as $\Theta_{i,1} > 0$.

2. With Frictional Non-Employment. Labour market frictions create additional redistribution motives even with equal wages ($w_i = \bar{w}$). Areas with high non-employment exhibit higher marginal utility of consumption due to two factors: a larger share of non-employed workers and reduced access to public goods. While these characteristics might suggest directing more funds to high-non-employment areas, the planner must consider countervailing efficiency costs. First, these areas produce lower tax revenues and output because higher non-employment rates correlate with reduced fiscal and agglomeration externalities. Second, redistribution can further depress labour force participation in the aggregate, creating a negative feedback loop. The planner, therefore, faces a fundamental trade-off between addressing distributional concerns and maintaining economic efficiency.

Our analysis shows that optimal policy typically favours areas with high labour force participation when two conditions are met: $\Theta_{i,2} > 0$ and the local congestion cost falls below the economy-wide average. In these cases, the budget savings and efficiency gains from higher tax revenues and expanded labour force participation outweigh the foregone benefits of redistributing to areas with the higher marginal utility of consumption.

We demonstrate these dynamics through simulations in Panel (b) of Figure 4, which shows the relationship between net transfers and relative non-employment rates for two locations $\xi_{h|i}/\xi_{h|j}$, using parameters calibrated to German data as detailed in Section 5. In the baseline scenario with equal wages across locations, net transfers are positive as long as $\xi_{h|i}/\xi_{h|j} < 1$ and the downward-sloping dashed blue line indicates optimal redistribution toward areas with lower non-employment rates (higher LFP), reflecting our finding that $\Theta_{i,2} > 0$ under realistic parameters.

The relationship becomes more complex when we allow both wages and non-employment rates to vary across regions. Their correlation critically determines optimal redistribution patterns. When non-employment correlates positively with wages (creating areas with low wages but high labour force participation), redistribution incentives are reinforced, provided both $\Theta_{i,1}$ and $\Theta_{i,2}$ are positive. This scenario, illustrated by the red dashed line in Panel (b), leads to increased transfers to low-wage, high-participation areas.

Conversely, when higher wages correlate with higher labour force participation–as we observe for male workers in Germany (Figure 1, Panel b)–the planner faces a more complex trade-off. The efficiency gains from redistributing to low-wage areas must be weighed against reduced tax revenue and labour force participation. Depending on the parametrization, this trade-off can even reverse the direction of optimal redistribution compared to the equal-wage scenario, highlighting the quantitative and qualitative importance of accounting for frictional non-employment in spatial policy design.

5 Quantification: Fiscal Redistribution System in Germany

We quantify our model for Germany, which provides an ideal setting due to its significant spatial heterogeneity in income and labour force participation, alongside its comprehensive fiscal redistribution scheme. Our analysis focuses on commuting zones (CZs) for the baseline year 2014.

5.1 Parametric Model

In Germany there are notable differences in the allocation of men and women across various occupational sectors. For instance, men are predominantly found in industries such as construction and manufacturing, while women are more commonly employed in service sectors, such as (public) administrative, social, and other services and activities. Hence, before quantifying the model, we extend our framework in Section 3 to include multiple market sectors. This extension is essential for capturing how men and women are concentrated in different industries or occupations and how these are distributed across heterogeneous local labour markets.

Workers in our extended model can move between regions and various market sectors ($u \in M \subset S$). They derive utility from consuming a bundle of tradeable goods and non-tradeable services, connected as a Cobb-Douglas aggregate with elasticities β_u. Workers' location choices depend on three factors: region-sector-specific wages, preferences for local public goods and amenities, and labour market frictions. These frictions comprise sector-specific participation costs $\exp\left[-\mu^g_{m|i,u}\right] \leq 1$ for joining market sector u in location i, on top of the worker-type-specific market friction term $\exp\left[\bar{B}^g_{h|i,u}\right] \varphi(\omega)$.

After workers select their region i and market sector u, idiosyncratic shocks determine their labour supply decisions. We denote the share of non-employed workers as $\xi^g_{h|i,u} \equiv L^g_{h|i,u}/L^g_{i,u}$, where $L^g_{i,u} \leq L^g_i$ represents the number of local workers in region i who would be employed in sector u if they were to join the labour force.

On the production side, firms combine labour, land and structures, and materials from all market sectors (Caliendo et al., 2018). The production technology incorporates input-output linkages, where $M_{i,uu'}$ represents material inputs from sector u' used by firms in region i and sector u. The parameter $\delta_{i,uu'}$ captures the share of materials from sector u' in sector u's production, while $\delta_{i,u}$ denotes the share of value added in gross output. Under constant returns to scale, these shares sum to unity: $\sum_{u' \in S} \delta_{i,uu'} = 1 - \delta_{i,u}$.

5.2 Data

Our quantification combines several complementary data sources. The core labour market data comes from the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) and the Federal Employment Agency, providing detailed information on the working-age population, labour force participation, and unemployment rates by gender at the local level.

To capture sectoral composition, we use employment shares from linked employer-employee data at the Institute for Employment Research (IAB, Sample of Integrated Labour Market Biographies (SIAB)) to allocate total employment across different market sectors.[11]

We also leverage the SIAB dataset to construct region-sector-specific wage measures by gender. We apply an AKM earnings model (Abowd et al., 1999) to individual wages, addressing wage censoring issues using the imputation method proposed by Card et al. (2013). We combine estimated fixed effects for each gender, region, and sector with national account data from the EU KLEMS Database to ensure consistency with aggregate wage measures.

The fiscal data follows the methodology of Henkel et al. (2021), combining various sources from German Statistical Offices (Statistisches Bundesamt, Destatis) to measure tax revenues and interregional transfers. We allocate federal, state, and municipal tax revenues to the commuting zone level and calculate corresponding fiscal transfers within and between Federal states.[12]

To capture local cost-of-living differences for the non-tradable sectors, we use

[11] "Weakly anonymous Version of the Sample of Integrated Labour Market Biographies (SIAB) - Version 7521 v1". Research Data Centre of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB). DOI: 10.5164/IAB.SIAB7521.de.en.v1. The 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. Our sample includes individuals aged 15-65 who are either employed or non-employed, excluding marginally employed, deceased or emigrated workers. See Table C.1 in the Online Supplement for our categorization of six 'market sectors' based on the ISIC 4 classification of economic activities.

[12] See Statistisches Bundesamt (2021b); Statistisches Bundesamt (2021a); Statistische Ämter des Bundes und der Länder (2021) for further details on the datasets used to construct local taxes and transfers.

regional price indices from two sources: Ahlfeldt et al. (2020) for real estate (serving as a proxy for construction sector prices) and Weinand and Auer (2020) for non-tradable service prices.[13]

For production structure and trade patterns, we combine several data sources. Gross output and value-added data come from EU KLEMS and regional economic accounts provided by the Statistical Office of the European Union (Eurostat). Input-output linkages are derived from World Input-Output Tables (WIOD). We measure trade flows using data from the Clearing House of Transport Data at the Institute of Transport Research of the German Aerospace Center (Schubert et al., 2014), which provides information on interregional trade between German districts. These flows are aggregated to match our commuting zone and sector-specific gross output data.

5.3 Parametrisation.

Baseline Parameters. We calibrate our model to match key observations from the German economy. The non-employment compensation is set to 62% of after-tax wages, reflecting Germany's first-tier unemployment benefit ('Arbeitslosengeld I'). Production parameters are calibrated to match observed data: the labour share in production $(1 - \kappa_{i,u})$ corresponds to labour payments relative to value-added, while value-added shares $\delta_{i,u}$ match their data counterparts, using output data from EU KLEMS and value-added data from the regional economic accounts of Eurostat. For the share of sector u goods used in sector u' and region i, $\delta_{i,u'u}$, we rely on national input-output shares $\delta_{u'u}$ from WIOD, noting that $\delta_{i,u'u} = (1 - \delta_{i,u'})\delta_{u'u}$.

For agglomeration economies in production, we use gender-specific productivity spillover estimates for Germany from Ahlfeldt et al. (2020): $\zeta^M = 0.018$ for males and $\zeta^F = 0.032$ for females, which fall well within the range of 0.01 to 0.06 documented in the literature (Rosenthal and Strange, 2004). We set amenity spillovers to $\eta = 0.3$ for both genders, matching the average across skill groups in Diamond (2016). The elasticity of substitution between male and female workers in production is set to $\sigma^g = 2.5$, consistent with estimates in Olivetti and Petrongolo (2014).[14]

Trade parameters follow standard values from the gravity literature (Head and Mayer, 2014). We set the elasticity of substitution across regions at $\sigma = 5$ and model trade costs for tradable sectors as $\tau_{ij,u} = dist_{ij}^{\zeta_u}$ with $\nu_u = 5$. Using equation (7) and our bilateral trade flow data, we estimate trade cost parameters $-\nu_u\zeta_u$ ranging from

[13]The real estate price indices follow the methodology of Combes et al. (2019), using micro-data from the Immobilien Scout 24 platform as documented in Boelmann and Schaffner (2019).

[14]This parameter varies by occupation, with estimates ranging from 1.2 to 2.7 in Mexico (Bhalotra and Fernández, 2018) and around 3 in the US (Acemoglu et al., 2004).

-1.43 to -2.14.

For public goods, we assume perfect rivalry ($\chi = 1$) and set the preference weight for local public services ($\alpha = 0.24$) and the Fréchet shape parameter ($\theta = 2$) following Fajgelbaum et al. (2019) – values that are also supported by local public finance data for Germany.[15] Lastly, we calibrate the expenditure shares across sectors to ensure that model-consistent expenditures across all regions result in aggregate goods market clearing.

Income Elasticities of Extensive Labour Supply. From equation (10) the elasticity of local labour supply to wage or income tax changes is captured by the following elasticity:

$$\frac{\partial L^g_{m|i,u}}{\partial (I^g_{m|i,u}/I^g_{h|i,u})} \frac{(I^g_{m|i,u}/I^g_{h|i,u})}{L^g_{m|i,u}} = \left[(1-\alpha)\,\epsilon^g \xi^g_{h|i,u}\right]\left(1-\xi^g_{h|i,u}\right)^{-1}.$$

We calibrate the income elasticities of extensive labour supply to 0.31 for males and 0.47 for females – values that align with evidence from European countries and the US (Mui and Schoefer, 2024). In particular, the male elasticity matches meta-analysis findings from Chetty et al. (2011), while the higher female elasticity reflects greater responsiveness to tax and wage changes among married women and single mothers as surveyed in the meta-analysis of Bargain and Peichl (2016). Combined with our public goods preference parameter ($\alpha = 0.24$) and observed average non-employment rates by gender across labour markets, these elasticities imply Pareto shape parameters of $\{\epsilon^M = 1.55; \epsilon^F = 1.56\}$.

Public Expenditure Elasticities of Labour Force Participation. We estimate the causal effect of public expenditure on labour force participation using quasi-experimental variation from Germany's 2011 Census. Our identification strategy exploits unexpected revisions to local population counts that determine fiscal transfer allocations (Helm and Stuhler, 2024; Serrato and Wingender, 2016). These Census-induced population adjustments, ranging from -7.65% to $+3.43\%$ across regions, generated permanent changes in local public resources from the fiscal redistribution scheme for reasons unrelated to economic or fiscal conditions.[16]

[15] Given Cobb-Douglas preferences, α represents the public goods expenditure share, which should equal the share of aggregate public expenditure to total value added. Local public finance data for Germany also suggests a similar value, which justifies our chosen value.

[16] We analyse district-level data for the pre-Covid period $2008-2018$, controlling for state-specific trends in the redistribution system and clustering standard errors at the labour market level. Online Supplement C.2 provides institutional details and estimation strategy information.

Given systematic differences in pre-treatment characteristics between affected regions (see Appendix Table C.2), we employ a difference-in-differences design with augmented inverse probability weighting (Sant'Anna and Zhao, 2020) to compare regions experiencing above-mean Census revisions (treated) to those below the mean (control). This approach accounts for observed differences in regional characteristics and pre-treatment dynamics by including four annual lags of our outcome variables. Event study estimates confirm parallel pre-trends in our outcome variables (Appendix Figure C.2). The analysis reveals that treated areas experienced a 167 Euros per capita increase in fiscal revenues (2.43%), leading to differential declines in non-employment rates: -1.31% for women and -0.94% for men (Table 1).[17]

Using our model framework, we translate these reduced-form effects into structural parameters. The compound spillover parameter $\gamma^g = \alpha\epsilon^g\rho_h^g$, combined with our calibrated values for α and ϵ^g, yields public goods elasticities of $\rho_h^F = (0.013/(1.56 * 2.43))/0.24 = 0.014$ for women and $\rho_h^M = 0.010$ for men.

Further analysis reveals that the heterogeneous effects across gender vary with local public service infrastructure. Appendix Table C.3 shows that that fiscal transfer shocks following the 2011 Census had the strongest impact in regions with limited childcare availability, where both female and male non-employment rates decrease by around 1.91%. In areas with above-median childcare access, the effects are substantially smaller and statistically insignificant for both groups. The pattern is similar for transport infrastructure: regions with poor transport connectivity show a modest decrease in female non-employment (-0.6%), while effects on male non-employment and in well-connected areas are insignificant.[18]

Local Market Frictions, Productivity, and Amenities. We recover region- and gender-specific fundamentals using our calibrated parameters that rationalize observed spatial patterns in the data. The model inversion yields estimates of market frictions ($B^g_{s|i}$), productivity levels, ($\bar{Z}_i^g$), and amenities, ($\bar{A}_i^g$) for each local labour market. We identify productivity levels as residuals from the labour demand equation after accounting for unit costs, while market frictions and amenities emerge as compensating differentials that explain observed patterns of labour supply and location choices. Online Supplement C.3 details the complete inversion strategy.

Figure 5 demonstrates the relationship between these recovered fundamentals

[17] These effects translate to reductions in non-employment rates of 0.38 percentage points for female workers and 0.2 percentage points for male workers.

[18] This aligns with findings from Helm and Stuhler (2024), who show that local governments in Germany respond to unforeseen lump-sum budget increases primarily through increased investment spending rather than debt restructuring, tax adjustments, or public employment changes.

Table 1: Effects of Fiscal Transfer Shocks on Employment

	ATT
Panel A. Public Finance	
Fiscal transfers per capita	167.34**
	(84.80)
Panel B. Non-employment rate	
– Female	-0.013**
	(0.006)
– Male	-0.009
	(0.013)
Observations	4,400
Controls	Yes
State × Year FE	Yes
Pre-treatment dynamics	Yes

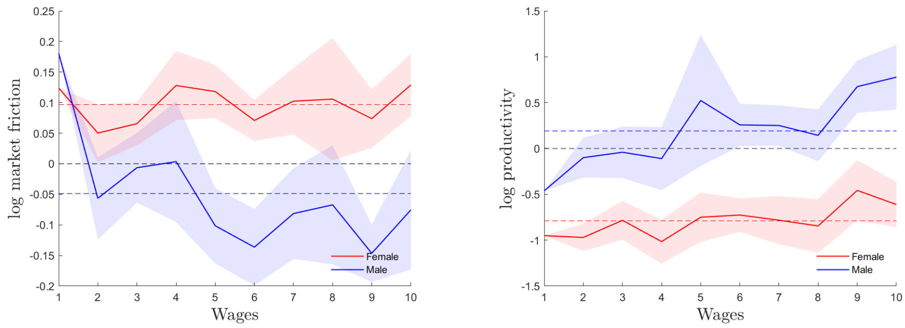
Notes: This table reports estimates of the effects of Census-induced fiscal transfer shocks on local non-employment. Panel A shows the first-stage relationship between Census revisions and fiscal transfers per capita (in euros). Panel B presents reduced-form effects on (log) non-employment rates by gender. Controls include log net wages. Pre-treatment characteristics include four annual lags of outcome variables. Standard errors (in parentheses) are clustered at the regional labour market level. + $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

and local wage levels. Panel (a) reveals systematic differences in market frictions across gender groups: male workers experience lower frictions in high-wage cities, consistent with better labour market access in urban areas. Female workers, by contrast, face relatively constant market frictions across the wage distribution, showing no systematic reduction in higher-wage areas. This pattern helps explain why female labour force participation does not necessarily increase with local wages, despite potentially higher returns to market work.

Panel (b) documents a positive relationship between (log) productivity and wages for both gender groups, consistent with established evidence on urban productivity advantages (Rosenthal and Strange, 2004). However, the persistence of high market frictions for women suggests that the productivity benefits of larger cities may not translate equally into improved labour market outcomes across demographic groups.

The analysis demonstrates that spatial variation in market frictions plays a central role in determining labour market outcomes, with particularly strong effects women. These patterns provide a structural interpretation of our reduced-form evi-

Figure 5: Stylised Facts about the Fundamentals



(a) Market frictions (b) Productivity

Notes: This figure shows the relationship between cross-sectionally demeaned log market frictions (Panel a) and log productivity (Panel b) against wage deciles for males and females. The dotted lines represent the mean across all commuting zones (CZs). Two solid lines are plotted, one for each gender, representing the demeaned average of each variable within each bin. The shaded areas around each line represent the 95% confidence interval.

dence on gender-specific responses to place-based policies.

6 Counterfactual Analysis

6.1 Optimal Spatial Policies

We analyse how spatial policies affect gender-specific labour market outcomes through counterfactual simulations based on our theoretical framework. Our analysis examines how optimized policies influence economy-wide outcomes, gender gaps in labour force participation and how these effects vary across local labour markets. Specifically, we investigate two questions: How do optimal spatial policies affect gender differences in employment across regions? What are the aggregate implications of optimizing spatial policy design in the presence of frictional labour markets?

Implementation Strategy. Our analysis solves for counterfactual equilibria through an iterative process that accounts for labour supply responses and general equilibrium effects. Given the structural parameters, exogenous fundamentals, endogenous variables $\{E_i, h_{i,u}, I^g_{s|i,u}, L^g_{i,u}, L^g_{s|i,u}, P_{i,u}, r_i, w^g_{u|i,u}, X_{i,u}, \lambda_{i,u}, \pi_{ij,u}\}$ and a set of spatial policies, we simulate how changes in spatial policies affect male and female employment decisions differently across local labour markets.

Starting from 2014 conditions, we calculate policy adjustments based on Proposition 2, incorporating gender-specific responses to tax rates and public goods provision. These policies affect location choices (via Eq. (11)) and local labour supply (via Eq. (10)) differently for men and women, generating changes in local wages, prices, and employment rates. Since optimal policies adjust endogenously to changes in these endogenous variables, we solve jointly for a set of endogenous variables and optimal policies until we find a new counterfactual equilibrium. We iterate this process until markets clear, social welfare (12) is maximised, and the aggregate resource constraint is satisfied, yielding equilibrium outcomes that reflect the set of fiscal policies that maximise welfare under gender-specific responses to policy changes.

To ensure we find the global maximum, we conduct $N = 10,000$ Monte Carlo simulations with different initial policy combinations before implementing the optimal spatial policies.[19] Each simulation generates a local maximum; we select the policy combination yielding the highest aggregate welfare improvement relative to 2014 baseline conditions. Please refer to our Online Supplement D.1 for further details and discussions on how we implement our Monte Carlo study with initial policy combinations and solve for counterfactual equilibria with optimized spatial policy as well as local and global maxima.

Key Policy Changes. The analysis reveals three key differences between the optimized spatial policy and Germany's current public finance system. First, examining the relationship between local tax rates and labour market conditions, as discussed in Section 4.3.1, shows important spatial patterns. Panel (a) of Figure 6 compares the current German system with a counterfactual scenario based on Proposition 2. The data indicate that current tax rates are higher in populous regions with high non-employment rates. The model suggests that lower tax rates in these areas could particularly benefit female employment, consistent with our empirical finding that women show stronger employment responses to fiscal changes.

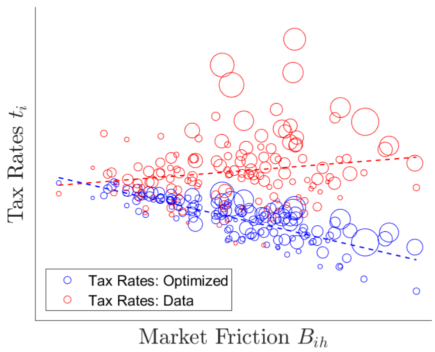
Second, the analysis reveals changes in the pattern of fiscal transfers between regions. Panel (b) of Figure 6 plots net fiscal transfers N_i against local wages. Given definition 2, we measure these transfers relative to a scenario without spatial redistribution. The model-generated transfers (in blue) show less dispersion and a weaker correlation with local wages than the current system. This pattern reflects how local labour market conditions interact with fiscal externalities: regions with high non-employment generate lower tax revenues despite potentially high productivity

[19] Equilibria are unique conditional on structural parameters and fundamentals but also an initial set of fiscal policies. Given inverted fundamentals and parameters while varying the (initial) sets of spatial policies, our approach allows us to find N localized maxima that are the outcome of implementing the optimal policies of Proposition 2 and are still consistent with a spatial equilibrium.

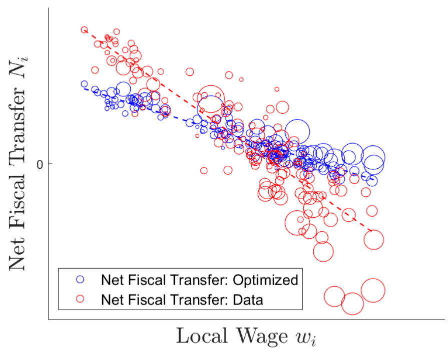
levels.

Third, the analysis shows that redistribution patterns vary systematically with local market frictions. High-wage urban locations exhibit larger gender gaps in labour force participation (Figure 1). The model indicates that when $\Theta_{i,2} > 0$, redistribution from these areas to low-wage regions involves a trade-off: while it may reduce spatial disparities, it can also decrease tax revenues, overall productivity, and aggregate labour force participation by shifting resources away from locations with high employment elasticities. Given our empirical estimates of gender-specific public goods elasticities ($\rho_h^F = 0.014$ for women and $\rho_h^M = 0.010$ for men), the model generates lower optimal redistribution levels compared to frameworks that abstract from labour force participation decisions Fajgelbaum and Gaubert (2020) and Henkel et al. (2021). This difference arises because our framework accounts for how spatial redistribution affects not only the location of economic activity but also local employment decisions (see Online Supplement D.2 for further details).

Figure 6: Optimal fiscal policies: Key Policy Changes



(a) Optimized Tax Rates



(b) Optimized Redistribution

Notes: This Figure highlights spatial fiscal policy for two different scenarios: (i) optimized policy instruments according to Proposition 2 and (ii) observed German public finance system in 2014 ("Data"). Panel (a) plots tax rates against inverted market frictions, while Panel (b) displays net fiscal transfers (see Definition 2) against local wages. The size of the marker is proportional to local labour market size.

Local and Aggregate Effects. Our analysis of spatial policy reveals differential impacts across regions, particularly in urban areas where we observe both high worker productivity and substantial gender gaps in employment. The model identifies two main adjustment margins: reallocation of workers across space and changes in local labour force participation. Areas experiencing enhanced consumption possibilities attract workers from elsewhere and show employment growth concentrated among female workers, consistent with our empirical finding that women exhibit stronger responses to fiscal shocks than men.

The analysis accounts for several equilibrating forces. As local employment grows, we observe increased congestion in public goods, higher non-tradable prices, and changes in local tax rates. These adjustments continue until expected utilities equalize across locations and labour market status.

Table 2 quantifies the aggregate effects. Column 1 shows that relative to the current system, the model generates an increase in the aggregate labour force of approximately $200,000$ workers, primarily through higher female employment. This expansion in labour supply is accompanied by sizeable increases in real GDP (1.68%) and welfare (2.59%). The employment effects are particularly pronounced in urban areas, where the model indicates larger reductions in gender gaps.

Gender gaps and urban premia. Our counterfactual analysis indicates changes in the relationship between urban wages and gender-specific employment rates. In the baseline data, women's non-employment rates are more than twice those of men in high-wage urban areas, while rural regions show more similar rates between genders (Figure 1). The model generates differential changes in these patterns following policy adjustments.

Sensitivity Analysis. We examine the robustness of our counterfactual results by re-calibrating the model across alternative values for the main parameters: (θ^g, ϵ^g), congestion (η), and agglomeration economies (ζ^g).

Column 2 of Table 2 analyses a version without endogenous labour force adjustment (see equation (10)). This specification, where $\epsilon^g \to \infty$, removes labour supply responses to fiscal policy, representing a scenario where local labour supply adjusts only through regional migration (Donald et al., 2024; Fajgelbaum and Gaubert, 2020, 2024). The results show smaller GDP and welfare gains in this case compared to our baseline model that incorporates gender-specific market frictions. The full employment framework generates smaller welfare gains from optimal policy due to high congestion effects in large cities reducing real GDP (Henkel et al., 2021). This difference demonstrates how accounting for heterogeneous responses to fiscal policy affects the measured benefits of optimally designed spatial redistribution.

The analysis of the remaining parameters $(\zeta^g, \eta, \theta^g)$ indicates that the main findings persist across reasonable parameter ranges. Columns (3)-(5) of Table 2 show variations in welfare gains across different parameter specifications: higher worker mobility (column 5) and lower urban congestion (column 4) lead to marginally larger welfare gains, as these factors facilitate migration to productive locations.

The central finding–that optimal policy involves reduced redistribution with the targeting of local labour force participation–remains consistent across all specifications. This stability stems from the model's fundamental economic mechanisms: efficiency and welfare gains emerge from the interaction between spatial redistribution, externalities, and heterogeneous labour supply elasticities, independent of specific parameter choices.

Table 2: Optimal Policies: Aggregate Effects

	(1) Full model	(2) $\epsilon^g \to \infty$	(3) $\zeta^g = 0$	(4) $\eta = 0$	(5) $\theta^g = 3$
Labour Force	198,290	-	197,534	198,629	238,110
Fiscal capacities (per capita)	6.06	3.86	6.00	6.04	7.37
Nominal GDP	2.30	-0.09	2.26	2.57	3.81
Real GDP	1.68	-0.62	1.67	1.88	2.87
Welfare	2.59	0.39	2.56	2.81	3.67

Notes: This table presents the nominal changes in the size of the labour force and percentage changes in aggregate outcomes–fiscal capacities (per capita), nominal and real GDP, and welfare. These variations result from counterfactual changes in spatial policies that implement optimal policies. We simulate counterfactual changes in 5 different scenarios: our preferred parametrization ("full model"), and four alternative specifications where we vary the main structural parameters of the model: $\{\epsilon^g, \zeta^g, \eta, \theta^g\}$

The quantitative analysis reveals two key patterns. First, incorporating labour force participation in the model substantially affects the predicted optimal policy configuration and reveals larger potential welfare gains and employment gains for female workers. Second, while regional redistribution remains important, the analysis indicates that a more targeted approach–emphasizing local labour force participation through lower tax rates and strategic public goods provision–could be more efficient than current redistributive practices.

—**Summary.** Our counterfactual analysis highlights the quantitative relationship between spatial policy and gender-specific labour market outcomes. The model demonstrates how heterogeneous labour market frictions across regions create a quantitative basis for improved spatial policy design. While complete elimination of these frictions would maximize efficiency, the second-best approach–focusing on optimizing fiscal resource distribution while taking them as exogenous in the short run– already identifies measurable welfare gains.

The analysis identifies two main channels through which spatial policies improve efficiency and labour force participation. First, changes in the regional distribution of resources alter migration patterns and local employment opportunities. Second, public goods provision affects labour force participation decisions, with particularly strong responses in regions where women face high barriers to employment.

Counterfactual simulations indicate that fiscal redistribution generates differential employment responses based on local infrastructure and market conditions. In urban areas, which show initially larger gaps in employment, changes in public goods provision impact labour force participation more strongly. These patterns contribute to our understanding of how spatial policies interact with local labour market conditions to influence local and aggregate outcomes.

7 Conclusion

This paper analyses how spatial policies affect gender-specific employment patterns across local labour markets. Our empirical analysis of Germany's fiscal transfer system reveals that place-based policies have differential effects on male and female employment, with women showing stronger responses to fiscal changes. These differences are particularly pronounced in regions with limited public goods provision, e.g. childcare facilities or transport infrastructure.

The analysis generates three main findings about the relationship between spatial policy and labour market outcomes. First, we propose a quantitative spatial framework that incorporates group-specific labour supply responses to fiscal policy. Comparison with a social planner allocation highlights new qualitative and quantitative predictions about the impact of spatial redistribution. Models that abstract from heterogeneous labour supply elasticities generate different implications for optimal transfer patterns and understate the benefit of optimising spatial policy design.

Counterfactual analysis suggests that regions differ systematically in how fiscal transfers affect male and female employment. Our simulations indicate that implementing alternative redistribution policies could expand female labour force participation by up to 5.7 percentage points in the most responsive locations, contributing to aggregate increases in real GDP (1.63%) and welfare (2.53%). These differences are largest in urban areas, where women's non-employment rates are more than twice those of men despite higher average wages.

Third, the data show systematic relationships between local infrastructure and gender-specific employment responses. Fiscal transfers generate the largest employment effects in regions with limited childcare access, where both female and male non-employment decrease by 1.91%. However, in areas with poor transport connectivity, only female non-employment shows significant responses (−0.6%).

Our framework provides predictions of how well-designed spatial policies increase labour force participation differently across local labour markets. These results are particularly relevant for policymakers in ageing economies that struggle with a shortage of skilled workers and limited government budgets. By incorporating heterogeneous responses to fiscal transfers and public goods provision, this paper helps explain observed patterns in regional employment gaps while identifying mechanisms through which the design of place-based policies can improve labour force participation of all demographic groups as well as economy-wide output and consumption possibilities.

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APPENDIX

A Social Planner Problem

This appendix supplements Section 4 in the main paper where we discuss optimal spatial policy in the presence of frictional non-employment. Here, we provide further details on the set-up of the social planner problem and show how it can be used to characterize optimal fiscal policies. We provide derivations for the most general scenario with multiple market sectors connected by input-output linkages as discussed in Section 5.1 of the main paper.

A.1 Set-up of the social planner problem

Using equation (12) the social welfare function is given as:

$$\mathcal{W} = \sum_{g \in G} \mu^g \mathcal{U} \left[\left(\sum_{u \in M} \sum_{i \in J} \left[A_i^g \exp\left[-\mu_{m|i,u}^g\right] \left(C_{m|i,u}^g\right)^{1-\alpha} \left(\frac{R_{m|i,u}^g}{\left(\sum_{g \in G} \sum_{u \in M} L_{i,u}^g\right)^{\chi}} \right)^{\alpha} \right.\right.\right.$$
$$\left.\left.\left. \left(1 + \frac{\left[\left(\frac{1}{\mathcal{B}_{s|i,u}^g}\right) \left(C_{m|i,u}^g / C_{h|i,u}^g\right)^{1-\alpha} \left(\left[\frac{R_{m|i,u}^g}{\left(\sum_{g \in G} \sum_{u \in M} L_{i,u}^g\right)^{\chi}} \right]^{\rho_h^g} \right)^{\alpha} \right]^{-\epsilon^g}}{\epsilon^g - 1} \right) \right]^{\theta} \right)^{\frac{1}{\theta}} \Gamma\left(\frac{\theta - 1}{\theta}\right) L^g \right]$$

The social planner maximises the social welfare function, subject to non-negativity constraints for consumption and production choices, resource constraints, supply of productive inputs, and workers' preferences as well as mobility. The following equations detail these constraints:

- Preferences:

$$\prod_{u'=1}^{M} \left(C_{s,u'|i,u}^g\right)^{\beta_{u'}^C} = C_{s|i,u}^g \quad \text{and} \quad \prod_{u'=1}^{M} \left(R_{m,u'|i,u}^g\right)^{\beta_{u'}^R} = R_{m|i,u}^g.$$

- Final goods resource constraints:

$$Y_{i,u'} = \sum_{s \in h,m} \sum_{u \in M} \sum_{g \in G} \xi_{s|i,u}^g C_{s,u'|i,u}^g L_{i,u}^g + \sum_{u \in M} \sum_{g \in G} \left(\frac{L_{i,u}^g}{L_i}\right) R_{m,u'|i,u}^g + \sum_{u \in M} \int M_{i,uu'}\left(\mathbf{z}_{\mathbf{u}'}\right) d\phi\left(\mathbf{z}_{\mathbf{u}'}\right)$$

where we let $Y_{i,u'} \equiv \left(\int \left(\sum_{j \in J} \tilde{y}_{ij,u'}\left(\mathbf{z}_{\mathbf{u}'}\right)\right)^{\frac{\sigma-1}{\sigma}} d\phi\left(\mathbf{z}_{\mathbf{u}'}\right) \right)^{\frac{\sigma}{\sigma-1}}$ denote the quantity produced of final goods in region-sector pair $\{i, u'\}$. Final goods produced in a given sectors are used for private and public consumption or as material inputs in other sectors. $\tilde{y}_{ij,u'}\left(\mathbf{z_{u'}}\right)$ is the input of intermediate goods produced in region j and sector u', but consumed in i.

- Intermediate goods resource constraints:

$$\left[\left(h_{i,u'}\left(z_{i,u'}\right)\right)^{\kappa_{i,u'}}\left(\left[\sum_{g\in G}\left(Z^g_{i,u'}L^g_{m|i,u'}\left(z_{i,u'}\right)\right)^{\frac{\sigma^g-1}{\sigma^g}}\right]^{\frac{\sigma^g}{\sigma^g-1}}\right)^{1-\kappa_{i,u'}}\right]^{\delta_{j,u'}}\prod_{u\in M}\left[M_{i,u'u}\left(z_{i,u'}\right)\right]^{\delta_{i,u'u}}$$
$$=\sum_{j\in J}\tau_{ji,u'}\tilde{y}_{ji,u'}\left(\mathbf{z_{u'}}\right)$$

- Supply of production inputs:

$$H_i=\sum_{u\in M}\int h_{i,u}\left(z_{i,u}\right)d\phi_i\left(z_{i,u}\right)\quad \text{and}\quad L^g_{m|i,u}=\int L_{m|i,u}\left(z_{i,u}\right)d\phi_i\left(z_{i,u}\right)$$

- Worker Sorting:

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

- Local labour supply:

$$\left(1-\left[\left(\frac{1}{\mathcal{B}^g_{s|i,u}}\right)\left(C^g_{m|i,u}/C^g_{h|i,u}\right)^{1-\alpha}\left(\left[\frac{R^g_{m|i,u}}{\left(\sum_{g\in G}\sum_{u\in M}L^g_{i,u}\right)\chi}\right]^{\rho^g_h}\right)^{\alpha}\right]^{-\epsilon^g}\right)L^g_{i,u}=L^g_{m|i,u}$$

A.2 Characterising Optimal Spatial Policies

In this section, we show how the set-up of the social planner problem allows to characterize the socially-optimal chocies of consumption, production, population and employment.

1. Consumption of goods in different sectors:

$$\frac{\partial\mathcal{W}}{\partial C^g_{s,u'|i,u}}:\quad L^g_{s|i,u}P_{i,u'}=\beta^C_{u'}\frac{C^g_{s|i,u}}{C^g_{s,u'|i,u}}P^g_{s|i,u},\tag{A.1}$$

where $P_{i,u'}$ denotes the Lagrange multiplier corresponding to the final goods resource constraint. $P^g_{s|i,u}$ is the multiplier on private consumption aggregation.

This condition implies an ideal price index $P_i \equiv \frac{P^g_{s|i,u}}{L^g_{s|i,u}} = \prod_{u'=1}^{M} \left(P_{i,u'}/\beta^C_{u'}\right)^{\beta^C_{u'}}$.

$$\frac{\partial \mathcal{W}}{\partial R^g_{s,u'|i,u}}: \quad P_{i,u'} \frac{L^g_{i,u}}{L_i} = \beta^R_{u'} \frac{R^g_{s|i,u}}{R^g_{s,u'|i,u}} \tilde{P}_{s|i,u}, \tag{A.2}$$

where $\tilde{P}_{s|i,u}$ is the Lagrange multiplier for the public good consumption aggregation, and we get an ideal price index for public goods: $P^R_i \equiv \tilde{P}_{s|i,u}\left(L_i/L^g_{i,u}\right) = \prod_{u'=1}^{M}\left(P_{i,u'}/\beta^R_{u'}\right)^{\beta^R_{u'}}$.

2. Local consumption of private and public goods:

$$\frac{\partial \mathcal{W}}{\partial C^g_{m|i,u}}: \quad \underbrace{\frac{(1-\alpha)\,\mu^g \mathcal{U}'(\mathcal{V}^g)\,\mathcal{V}^g}{C^g_{m|i,u}}\left[\frac{\epsilon^g - 1}{\epsilon^g - 1 + \xi^g_{h|i,u}}\right]}_{\text{marginal utility of consumption (per capita)}} \tag{A.3}$$
$$= P_i - \underbrace{\sum_{j \in J}\sum_{u' \in M} W^g_{j,u'}\Psi^g_{j,u'}/\left(1-\xi^g_{h|i,u}\right)}_{\text{sorting across region-sectors}} - \underbrace{\frac{\tilde{W}^g_{m|i,u}\left[(1-\alpha)\,\epsilon^g\right]\xi^g_{h|i,u}}{\left(1-\xi^g_{h|i,u}\right)C^g_{m|i,u}}}_{\text{selection along extensive margin}},$$

where $W^g_{j,u}$ and $\tilde{W}^g_{m|i,u}$ are the Lagrange multipliers on the regional and extensive labour supply constraints, respectively, $\mathcal{V}^g$ is the equalised indirect utility for each worker group, and the $\Psi^g_{j,u'}$ are given as:

$$\Psi^g_{j,u'} = \begin{cases} -\left(L^g_{j,u'}/L^g\right)\left(\frac{(1-\alpha)\theta}{C^g_{m|i,u}}\right)\left[\frac{(\epsilon^g-1)(1-\xi^g_{h|i,u})}{\epsilon^g-1+\xi^g_{h|i,u}}\right] & \text{if } \{i,u\} \neq \{j,u'\} \\ \left(1-\frac{L^g_{i,u}}{L^g}\right)\left(\frac{(1-\alpha)\theta}{C^g_{m|i,u}}\right)\left[\frac{(\epsilon^g-1)(1-\xi^g_{h|i,u})}{\epsilon^g-1+\xi^g_{h|i,u}}\right] & \text{if } \{i,u\} = \{j,u'\}. \end{cases}$$

$$\frac{\partial \mathcal{W}}{\partial C^g_{h|i,u}}: \quad \underbrace{\frac{(1-\alpha)\,\mu^g \mathcal{U}'(\mathcal{V}^g)\,\mathcal{V}^g}{C^g_{h|i,u}}\left[\frac{\epsilon^g}{\epsilon^g - 1 + \xi^g_{h|i,u}}\right]}_{\text{marginal utility of consumption (p.c.)}} \tag{A.4}$$
$$= P_i - \underbrace{\sum_{j \in J}\sum_{u' \in M} W^g_{j,u'}\Psi^g_{j,u',h}/\xi^g_{h|i,u}}_{\text{sorting across region-sectors}} + \underbrace{\frac{\tilde{W}^g_{m|i,u}\left[(1-\alpha)\,\epsilon^g\right]\xi^g_{h|i,u}}{\xi^g_{h|i,u}C^g_{h|i,u}}}_{\text{selection along extensive margin}},$$

where we denote as $\Psi^{g}_{j,u',h}$ the following components:

$$\Psi^{g}_{j,u',h} = \begin{cases} -\left(L^{g}_{j,u'}/L^{g}\right)\left(\frac{(1-\alpha)\theta}{C^{g}_{h|i,u}}\right)\left[\frac{\epsilon^{g}\xi^{g}_{h|i,u}}{\epsilon^{g}-1+\xi^{g}_{h|i,u}}\right] & \text{if } \{i,u\} \neq \{j,u'\} \\ \left(1-\frac{L^{g}_{i,u}}{L^{g}}\right)\left(\frac{(1-\alpha)\theta}{C^{g}_{h|i,u}}\right)\left[\frac{\epsilon^{g}\xi^{g}_{h|i,u}}{\epsilon^{g}-1+\xi^{g}_{h|i,u}}\right] & \text{if } \{i,u\} = \{j,u'\}. \end{cases}$$

$$\frac{\partial \mathcal{W}}{\partial R^{g}_{m|i,u}} : \quad \underbrace{\mu^{g}\mathcal{U}'\left(\mathcal{V}^{g}\right)\mathcal{V}^{g}/R^{g}_{m|i,u}\left[\alpha-\Upsilon^{g}_{i,u}\right]}_{\text{marginal utility of consumption}} \tag{A.5}$$

$$= \frac{P^{R}_{i}}{L_{i}} - \underbrace{\sum_{j\in J}\sum_{u'\in M} W^{g}_{j,u}\Psi^{g,R}_{j,u'}}_{\text{sorting across region-sectors}} - \underbrace{\tilde{W}^{g}_{m|i,u}\left[\alpha\epsilon^{g}\rho^{g}_{h}\right]\xi^{g}_{h|i,u}/R^{g}_{m|i,u}}_{\text{selection along extensive margin}},$$

$$\Psi^{g,R}_{j,u'} = \begin{cases} -\left(L^{g}_{j,u'}/L^{g}\right)\left(\frac{\theta}{R^{g}_{m|i,u}}\right)\left[\alpha-\Upsilon^{g}_{i,u}\right] & \text{if } \{i,u\} \neq \{j,u'\} \\ \left(1-\frac{L^{g}_{i,u}}{L^{g}}\right)\left(\frac{\theta}{R^{g}_{m|i,u}}\right)\left[\alpha-\Upsilon^{g}_{i,u}\right] & \text{if } \{i,u\} = \{j,u'\}. \end{cases}$$

with $\Upsilon^{g}_{i,u} \equiv \frac{\gamma^{g}\xi^{g}_{h|i,u}}{\epsilon-(1-\xi^{g}_{h|i,u})}$ and $\gamma^{g} = \alpha\rho^{g}_{h}\epsilon^{g}$ is the spillover from public expenditure to local non-employment.

3. Production inputs:

$$\frac{\partial \mathcal{W}}{\partial L^{g}_{m|i,u}\left(z_{i,u}\right)} : \quad \tilde{\lambda}_{i,u}\left(z_{i,u}\right)\delta_{i,u}\left(1-\kappa_{i,u}\right)\frac{\left(\frac{Z^{g}_{i,u}}{w^{g}_{i,u}}\right)^{\sigma^{g}-1}}{\sum_{g\in G}\left(\frac{Z^{g}_{i,u}}{w^{g}_{i,u}}\right)^{\sigma^{g}-1}}\frac{\sum_{j\in J}\tau_{ji,u}\tilde{y}_{ji,u}\left(z_{i,u}\right)}{L^{g}_{m|i,u}\left(z_{i,u}\right)}$$

$$= w^{g}_{i,u}d\phi\left(z_{i,u}\right) \tag{A.6}$$

where $\tilde{\lambda}_{i,u}\left(z_{i,u}\right)$ and $w^{g}_{i,u}$ are the Lagrange multipliers on the intermediate goods constraint and resource constraint for local labour respectively. Also,

$$\frac{\partial \mathcal{W}}{\partial h_{i,u}\left(z_{i,u}\right)} : \quad \tilde{\lambda}_{i,u}\left(z_{i,u}\right)\delta_{i,u}\kappa_{i,u}\frac{\sum_{j\in J}\pi_{ji,u}\tilde{y}_{ji,u}\left(z_{i,u}\right)}{h_{i,u}\left(z_{i,u}\right)} = r_{i}d\phi\left(z_{i,u}\right), \tag{A.7}$$

where we denote as r_i the Lagrange multiplier on the resource constraint for land and structures. Similarly, the materials input is derived as follows:

$$\frac{\partial \mathcal{W}}{\partial M_{i,uu'}\left(z_{i,u}\right)} : \quad \tilde{\lambda}_{i,u}\left(z_{i,u}\right)\delta_{i,uu'}\frac{\sum_{j\in J}\pi_{ji,u}\tilde{y}_{ji,u}\left(z_{i,u}\right)}{M_{i,uu'}\left(z_{i,u}\right)} = P_{i,u'}d\phi\left(z_{i,u}\right). \tag{A.8}$$

Using the first-order conditions (A.6) - (A.8) in the intermediate goods resource constraint, we derive the optimal region-sector-specific unit cost index:

$$\tilde{\lambda}_{i,u}\left(z_{i,u}\right) \equiv \frac{\lambda_{i,u} d\phi(z_{i,u})}{z_{i,u}} = \frac{D_{i,u}}{z_{i,u}} \left(r_i^{\kappa_{i,u}} \left[\sum_{g \in G} \left(\frac{Z_{i,u}^g}{w_{i,u}^g} \right)^{\sigma^g - 1} \right]^{\frac{1-\kappa_{i,u}}{1-\sigma^g}} \right)^{\delta_{i,u}} \prod_{u' \in M} \left[P_{i,u'}\right]^{\delta_{i,uu'}} d\phi(z_{i,u}),$$

with $D_{i,u} \equiv \left(\delta_{i,u}\left(\kappa_{i,u}\right)^{\kappa_{i,u}}\left(1-\kappa_{i,u}\right)^{(1-\kappa_{i,u})}\right)^{-\delta_{i,u}} \prod_{u' \in M}\left(\delta_{i,uu'}\right)^{-\delta_{i,uu'}}$ a region-sector-specific constant. The social planner similarly optimises with respect to intermediate goods production and consumption in region-sector pair $\{i, u'\}$:

$$\frac{\partial \mathcal{W}}{\partial \tilde{y}_{ji,u'}\left(\mathbf{z_{u'}}\right)} : \begin{cases} \tilde{y}_{ji,u'}\left(\mathbf{z_{u'}}\right) > 0 \text{ if } & \tilde{\lambda}_{j,u}\left(z_{j,u}\right) \tau_{ij,u} = P_{i,u} \left(\frac{Y_{i,u}}{\tilde{y}_{ij,u'}(\mathbf{z_u})} \right)^{\frac{1}{\sigma}} d\phi\left(z_{j,u}\right) \\ \tilde{y}_{ji,u'}\left(\mathbf{z_{u'}}\right) = 0 \text{ if } & \tilde{\lambda}_{j,u}\left(z_{j,u}\right) \tau_{ij,u} > P_{i,u} \left(\frac{Y_{i,u}}{\tilde{y}_{ij,u'}(\mathbf{z_u})} \right)^{\frac{1}{\sigma}} d\phi\left(z_{j,u}\right) \end{cases}$$

This first-order condition can be re-written as $\tilde{y}_{i,u}\left(\mathbf{z_u}\right) = \left(p_{i,u}\left(\mathbf{z_u}\right)\right)^{-\sigma} P_{i,u}^{\sigma-1}\left(Y_{i,u} P_{i,u}\right)$, using the fact that prices equal unit costs under perfect competition and with $\tilde{\lambda}_{i,u}\left(z_{i,u}\right) \equiv p_{i,u}(z_{i,u}) d\phi(z_{i,u})$ if producers choose minimal unit costs. It is easily seen that this first-order condition implies the same trade shares and price levels as in the competitive equilibrium.

4. Local labour force:

$$\frac{\partial \mathcal{W}}{\partial L_{m|i,u}^g} : \; w_{i,u}^g = \tilde{W}_{m|i,u}^g. \tag{A.9}$$

5. Worker Allocation across space:

Let $\mathrm{Ex}_i^{\mathrm{NET}} \equiv \underbrace{\mathrm{Ex}_i^{\mathrm{AGG}}}_{\substack{\text{spillovers on} \\ \text{productivity}}} - \underbrace{\mathrm{Ex}_i^{\mathrm{LFP}}}_{\substack{\text{spillovers on} \\ \text{local labour force}}} - \underbrace{\mathrm{Ex}_i^{\mathrm{CON}}}_{\substack{\text{congestion spillovers on} \\ \text{public goods consumption}}}$. It follows that:

$$\begin{aligned} \frac{\partial \mathcal{W}}{\partial L_{i,u}^g} : \quad & \underbrace{W_{i,u}^g}_{\text{opportunity cost}} + \underbrace{\sum_{u' \in M} P_{i,u'} \left[\xi_{h|i,u}^g C_{h,u'|i,u}^g + \left(1 - \xi_{h|i,u}^g\right) C_{m,u'|i,u}^g \right]}_{\text{consumption cost}} \\ & = \underbrace{\left(1 - \xi_{h|i,u}^g\right) \tilde{W}_{m|i,u}^g}_{\text{marginal product of labour}} + \underbrace{Ex_i^{NET}}_{\text{net spatial externalities}}, \end{aligned} \tag{A.10}$$

Productivity spillovers are given as

$$Ex_i^{AGG} \equiv \sum_{u \in M} \sum_{g \in G} \int \zeta^g \delta_{i,u}\left(1-\kappa_{i,u}\right) \frac{\left(\frac{Z_{i,u}^g}{w_{i,u}^g}\right)^{\sigma^g-1}}{\sum_{g \in G}\left(\frac{Z_{i,u}^g}{w_{i,u}^g}\right)^{\sigma^g-1}} \frac{\sum_{j \in J} \tau_{ji,u} \tilde{y}_{ji,u}\left(z_{i,u}\right)}{\sum_{u \in M} \sum_{g \in G} L_{i,u}^g} p_{i,u}(z_{i,u}) d\phi\left(z_{i,u}\right).$$

Integration of equation (A.6) and combination with the definition of agglomeration economies yields

$$Ex_i^{AGG} = \sum_{u \in M} \sum_{g \in G} \zeta^g \left(1 - \xi^g_{h|i,u}\right) w^g_{i,u} \left(\frac{L^g_{i,u}}{L_i}\right) \tag{A.11}$$

Using the first-order condition (A.9), labour force spillovers are derived as

$$Ex_i^{LFP} = \chi \sum_{u \in M} \sum_{g \in G} \gamma^g \xi^g_{h|i,u} w^g_{u|i,u} \left(\frac{L^g_{i,u}}{L_i}\right). \tag{A.12}$$

Congestion spillovers on amenity and public goods consumption are given by

$$Ex_i^{CON} = \frac{1}{\sum_{g \in G} \sum_{u \in M} L^g_{i,u}} \sum_{g \in G} \left(\mu^g \mathcal{U}'\left(\mathcal{V}^g\right) \mathcal{V}^g \sum_{u \in M} L^g_{i,u} \left(\chi \left(\alpha - \Upsilon^g_{i,u}\right) + \eta\right) \right).$$

In our Online Supplement we show that expected utility can be further expressed as

$$\left(1 - \alpha\right) \mu^g \mathcal{U}'\left(\mathcal{V}^g\right) \mathcal{V}^g = \frac{1}{L_g} \sum_{i \in J} \sum_{u \in M} L^g_{i,u} \left[P_i \sum_{s \in h,m} \xi^g_{s|i,u} C^g_{s|i,u} \right]$$

Using this equation in the definition of Ex_i^{CON} we finally get:

$$\begin{aligned} Ex_i^{CON} = \frac{1}{(1-\alpha)} \sum_{g \in G} \Bigg[\frac{1}{L_g} \Bigg(\sum_{i \in J} \sum_{u \in M} L^g_{i,u} \Bigg[\sum_{s \in h,m} \xi^g_{s|i,u} \left(\left(1 - \tilde{t}^g_{s|i,u}\right) w^g_{i,u} + \tilde{s}^g_{s|i,u} \right) \Bigg] \Bigg) \\ \times \sum_{u \in M} \left(\frac{L^g_{i,u}}{L_i}\right) \left(\chi \left(\alpha - \Upsilon^g_{i,u}\right) + \eta\right) \Bigg]. \end{aligned} \tag{A.13}$$

Combining Equations (A.10), (A.11), (A.12) and (A.13), and applying it for the special case with $M = G = 1$, yields Equation (13) in the main paper and proves Proposition 1.

A.3 Optimal Spatial Policies - Proof of Proposition 2

In this Appendix we outline the steps necessary to derive the optimal taxes and transfers that implement the socially optimal levels of private and public good consumption by combining the planner's first-order conditions. We provide an overview of the main steps here. For interested readers, detailed derivations are available in our Online Supplement, where we explain how to implement each step individually.

1. Solve for the optimal private goods consumption of employed and non-employed workers in all regions, sectors and groups, by combining (A.3), (A.4), (A.9) and the planner's first-order condition on local population (A.10).

2. Step 1 yields optimal private good consumption levels as a function of wages, employment rates and two policy instruments: region-specific tax rates, $\tilde{t}^{g}_{s|i,u}$ on local labour income as well as additive wage subsidies $\tilde{x}^{g}_{s|i,u}$.

3. Using the general equilibrium structure of the framework and again applying the planner's first-order condition on local population (A.10), all policy instruments can be expressed using solely information on observable variables at the regional level (e.g. wages, employment, rents and labour force participation rates), structural parameters and the optimal level of local public good provision.

4. Derive the optimal level of public good consumption, using equations (A.5), (A.9), the planner's first-order condition on local population (A.10) as well as the solutions for private good consumption from step 2.

5. Again using the general equilibrium structure of the framework, local public good levels can be expressed solely as a function of economic variables at the local level (wages, rents, population, labour force participation rates) as well as structural parameters of the model.

6. Determine private goods consumption expenditures using the previously solved levels of public goods expenditure.

The optimal consumption levels, as well as socially optimal taxes and transfers as derived in 2 follow from applying these six steps. See Section B in our Online Supplement for detailed calculations.

ONLINE SUPPLEMENT

This Online Supplement complements the paper "Spatial Policies and Gender Gaps in Local Labour Supply". Section A supplements Section 3 of the main paper, providing further details on the derivation of expected utilities, the general equilibrium of our framework and detailing how our model links to dynamic macro models of frictional unemployment. In Section B, we provide detailed derivations and further discussion how the social planner set-up allows to solve for optimal spatial policy instruments.

Section C complements Section 5 of the main paper, detailing how we combine our data from German labour markets with the structure of the framework to invert the fundamentals of the economy. Finally, we include additional details on its implementation, as well as results and robustness checks from our counterfactual analysis in Section D.

A Online Supplement: Theory

A.1 Deriving Expected Utility

Given the definition of market frictions, $\exp\left[B^g_{h|i,u}\right]\varphi(\omega)$, the average size of market frictions for non-employed workers is given as

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

where $Q^g(\varphi)$ is the cumulative distribution function of workers' individual market friction draws. Only those workers whose individual draw is above a local cutoff $\tilde{\varphi}^g_{h|i,u}$ end up in the home market sector, such that the average level of market frictions can be re-written as

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

with $L^g_{h|i,u}/L^g_{i,u}=1-Q^g\left(\tilde{\varphi}^g_{h|i,u}\right)$ 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:

$$Q^g(\varphi) = 1 - \varphi^{-\epsilon^g} \quad \text{and} \quad \frac{\partial Q^g(\varphi)}{\partial \varphi} = \epsilon^g \varphi^{-\epsilon^g - 1}$$

Substituting these functional forms into the expression above yields

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

Comparing individual utility under either employment status yields the size of the local cutoff. Thus we get

$$\int_{\tilde{\varphi}^g_{h|i,u}}^{\infty} \varphi dQ^g(\varphi) = \frac{\epsilon^g}{\epsilon^g - 1} \left(\left(\frac{1}{\mathcal{B}^g_{s|i,u}}\right)\left(\frac{I^g_{m|i,u}}{I^g_{h|i,u}}\right)^{1-\alpha} \left(\left[\frac{R_i}{L^\chi_i}\right]^{\rho^g_h}\right)^{\alpha}\right)^{1-\epsilon^g}.$$

Collecting terms, we arrive at

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

Using this expression for the average level of market frictions, we derive expected indirect utility in region i and market sector u as follows:

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

For the special case where $M = 1$, we get the expression for indirect utilities in equation (11) of the main paper.

A.2 General Equilibrium

In this Supplement, we detail the general equilibrium of the quantitative framework. Given model primitives, a general equilibrium of the economy is referenced by a vector of endogenous objects $\mathbf{V} = \{E_i, h_{i,u}, I^g_{s|i,u}, L^g_{i,u}, L^g_{s|i,u}, P_i, r_i, w^g_{i,u}, X_{i,u}, \lambda_{i,u}, \pi_{ij,u}\}$. These endogenous objects are jointly determined such that:

1. Workers optimally choose bundles of final goods from all markets given region-specific price indices for all market sectors and after-tax income;

2. Workers optimally sort into locations and market sectors, given after-tax income, public expenditure, local amenities and regional price levels:

$$L^g_{i,u} = \frac{\left(A^g_i \exp\left[-\mu^g_{m|i,u}\right]\left(\frac{I^g_{m|i,u}}{P_i}\right)^{1-\alpha}\left(\frac{R_i}{L^X_i}\right)^{\alpha}\left(1+\xi^g_{h|i,u}\left[\frac{\epsilon^g}{\epsilon^g-1}-1\right]\right)\right)^{\theta}}{\sum_{i\in J}\sum_{u\in M}\left(A^g_i \exp\left[-\mu^g_{m|i,u}\right]\left(\frac{I^g_{m|i,u}}{P_i}\right)^{1-\alpha}\left(\frac{R_i}{L^X_i}\right)^{\alpha}\left(1+\xi^g_{h|i,u}\left[\frac{\epsilon^g}{\epsilon^g-1}-1\right]\right)\right)^{\theta}} L^g$$

3. Workers decide on their labour force participation after their workplace decision:

$$L^g_{h|i,u} = \left[\underbrace{\left(\exp\left[\mathcal{B}^g_{s|i,u}\right]\right)^{-1}}_{\text{Market Frictions}}\underbrace{\left(\frac{I^g_{m|i}}{I^g_{h|i}}\right)^{1-\alpha}\left(\left[\frac{R_i}{L^X_i}\right]^{\rho^g_h}\right)^{\alpha}}_{\text{Spatial Policies}}\right]^{-\epsilon^g} L^g_i.$$

4. Intermediate good producers demand materials, labour, as well as land and structures under unit costs in a Cobb-Douglas production function. These productive inputs are used to produce idiosyncratic intermediate good varieties.

5. Final goods producers import intermediates from the least cost intermediate producers according to equation (7) in the main paper;

6. Trade costs and unit cost determine optimal price indices

7. Final goods market clearing implies

$$\begin{aligned} X_{i,u} =& \beta^R_u\left[\left(\sum_{u'\in M}\sum_{g\in G}\left(t^g_{m|i,u'}+\iota_i\right)(1-\xi^g_{h|i,u'})w^g_{i,u'}L^g_{i,u'}\right)\right] \\ &+\beta^C_u\left[\frac{L_i}{L}\left(\sum_{j\in J}\sum_{u'\in M} r_j h_{j,u'} - \sum_{g\in G}(1-t^g_{h|i,u'})\xi^g_{h|j,u'}w^g_{j,u'}L^g_{j,u'}\right)\right. \\ &\left.+\sum_{s\in h,m}\sum_{u'\in M}\sum_{g\in G}\left(1-t^g_{s|i,u'}\right)\xi^g_{s|i,u'}w^g_{i,u'}L^g_{s|i,u'}\right] + \sum_{u'\in M}\delta_{i,u'u}\sum_{j\in J}\pi_{ji,u'}X_{j,u'} \end{aligned}$$

8. Labour demand implies

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

where $\sum_{j\in J}\pi_{ji,u}X_{j,u}$ are expenditures in all locations j on goods produced in region i and sector u.

9. Market clearing for land and structures implies

$$h_{i,u}=\frac{\delta_{i,u}\kappa_{i,u}}{r_i}\sum_{j\in J}\pi_{ji,u}X_{j,u}.$$

Land and structures market clearing for all regions $i\in J$ and market sectors $u\in M$ ensures that demand for land and structures (9) equals the exogenous supply of land and structures $H_i=\sum_{u\in M}h_{i,u}$.

10. Demand for materials is given by

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

11. The local governments' budget constraint reads

$$E_i=\sum_{u\in M}\sum_{g\in G}(t^g_{m|i,u}+\iota_i)(1-\xi^g_{h|i,u})w^g_{i,u}L^g_{i,u}$$

The system of equations is over-identified (by one equation in total), meaning there are more equations than unknowns. To solve this, we normalise the aggregate price level in the economy and treat it as the numéraire in the system, e.g.

$$\sum_{i\in J}P_iL_i/L\equiv\bar{P}=1.$$

This equation also pins down aggregate welfare in the economy.

A.3 Micro-Foundation of Labour Force Participation

This Online Supplement Section provides a micro-foundation of the labour supply equation where we identify the role of labour market frictions for labour force participation (see equation (10) in the main paper). This micro-foundation is based on a stylised search-and-matching framework with frictional unemployment, drawing inspiration from previous work in Kline and Moretti (2013). This approach allows to connect our results to existing research on spatial sorting and frictional unemployment.

Model Setup. We consider a similar setup as in the spatial equilibrium framework of section 3 of the main paper. For tractability, we, however, assume that workers and firms are homogeneous, exclude frictional trade and suppress the sub-scripts for heterogeneous worker groups.

The economy has L individuals who can move freely across $i \in J$ regions, work in the market sector $m \in S$ or join the home market sector h. Each worker demands one unit of a non-tradable final good, with prices equal to marginal production costs ($P_i = \lambda_i$). Workers and firms are matched according to a constant-returns-to-scale matching function, $\mathcal{M}_i(L_{h|i}, O_i)$, where $L_{h|i}$ denotes unemployed workers, and O_i represent the open vacancies in labour market i.

We assume a logarithmic utility function for all workers. Unemployed workers derive utility from local amenities A_i, private goods, public goods, and the flow utility of unemployment $\tilde{B}_i$, which includes non-employment benefits and the value of leisure. The transition of workers to employment depends on the number of open vacancies and non-employed workers. Firms face costs related to posting job openings and hiring workers, including a sunk flow cost of k and a hiring cost of H_i. These costs and worker-firm match productivity (Z_i) influence job creation and posting dynamics. Firms are owned by immobile capital owners. Workers and firms discount the future at a common rate r.

Value functions. In steady-state, the value of non-employment is

$$rJ_{h|i} = \ln(\tilde{B}_i) + \ln(A_i) - (1-\alpha)\ln(P_i) + \alpha\left(1 - \tilde{\rho}_h\right)\ln(R_i/L_i^{\chi}) + \upsilon_i q_i(\upsilon_i)\left(J_{m|i} - J_{h|i}\right),$$

where $\upsilon_i = \frac{O_i}{L_{h|i}}$ represents market tightness, and $q_i(\upsilon_i) = \frac{\mathcal{M}_i}{O_i}$ denotes the job finding rate. The steady-state value of market employment $J_{m|i}$ relates to:

$$rJ_{m|i} = (1-\alpha)\ln w_i + \ln A_i + \alpha\ln(R_i/L_i^{\chi}) - (1-\alpha)\ln(P_i) + o_i\left(J_{h|i} - J_{m|i}\right),$$

with w_i being workers' market wage and o_i representing an exogenous separation probability. Worker mobility ensures that the expected utility of being non-employed is equalised across the economy, resulting in $rJ_{h|i} = rJ_h = \mathcal{V}$ for all $i \in J$.[20]

In steady state, firms and workers are matched with a certain probability, and an open vacancy is filled. The value of this filled vacancy $J_{F|i}$ satisfies

$$rJ_{F|i} = \ln(Z_i) - \ln(w_i) + o_i\left(J_{O|i} - J_{F|i}\right),$$

[20] Alternatively, one could assume that the expected utility of being non-employed or employed must be equalised across locations as in our generalised framework in the main paper. Introducing this assumption will, however, not impact the main predictions from this Supplement.

where $J_{O|i}$ is the steady-state value of opening a vacancy. Since firms incur costs of vacancy posting irrespective of obtaining a match, the value of opening vacancies is driven to zero by free firm entry and given by:

$$rJ_{O|i} = -k + q_i(\upsilon_i)\left(J_{F|i} - J_{O|i} - H_i\right).$$

In spatial equilibrium, worker reallocation across regions is determined by inflow and outflow rates, resulting in the local non-employment rate:

$$\xi_{h|i} = \frac{L_{h|i}}{L_i} = \frac{o_i}{o_i + \upsilon_i q_i(\upsilon_i)}.$$

In less tight markets, we can approximate the non-employment rate as follows:

$$\ln \xi_{h|i} \approx -\upsilon_i q_i(\upsilon_i)/o_i.$$

Equilibrium. Workers and firms bargain over the surplus generated by the match:

$$J_{m|i} - J_{h|i} = \frac{b}{1-b}\left(J_{F|i} - J_{O|i} - H_i\right),$$

with b the workers' Nash bargaining share of the surplus. Substituting the values for employment and unemployment as well as the value of matching in the previous expression, we get an expression for regional wages:

$$\ln w_i = \frac{1}{1-\alpha(1-b)}\left[b\left(\ln Z_i - (r+o_i)\,H_i\right) + (1-b)\left((1-\alpha)\ln P_i + \mathcal{V} - \ln A_i - \alpha\ln(R_i/L_i^{\chi})\right)\right].$$

Combining the steady-state values for vacancy posting and matches, the job creation side of the model requires that:

$$q_i\left(\upsilon_i\right) = \frac{k\left(o_i + r\right)}{\ln Z_i - \ln w_i - \left(o_i + r\right)H_i}.$$

After integrating the values of employment and non-employment, incorporating the job-finding rate, applying the wage expression, and substituting the market tightness expression, we obtain the following through algebraic manipulation:

$$\mathcal{V} + (1-\alpha)\ln P_i - \ln A_i = k\upsilon_i\frac{b}{1-b} + \tilde{B}_i + \alpha\left(1-\tilde{\rho}_h\right)\ln(R_i/L_i^{\chi}).$$

After substituting this equation into the wage expression, we arrive at the following expression:

$$\ln w_i = \frac{1}{1-\alpha(1-b)} \left[b \left(\ln Z_i - (r + o_i) H_i + k\upsilon_i \right) + (1-b) \left(\tilde{B}_i - \alpha \tilde{\rho}_h \ln(R_i/L_i^{\chi}) \right) \right].$$

This equation illustrates how the wage is determined by the bargaining power (b), weighted average of match productivity (Z_i) net of hiring costs (H_i) and the necessary flow for workers to obtain the utility level $\mathcal{V}$. This utility level represents the flow utility of unemployment $\tilde{B}_i$ net of public goods provision (R_i/L_i^{χ}).

Leveraging the relationship between non-employment rates and labour market tightness, we derive an expression for the logarithm of non-employment rates as a function of the logarithm of wages, public goods, and exogenous components:

$$\begin{aligned} \ln \xi_{h|i} = &- \left(\frac{q_i(\upsilon_i)}{k o_i} \right) \left(\frac{1-\alpha(1-b)}{b} \ln w_i - \ln Z_i - \frac{(1-b)\alpha\tilde{\rho}_h}{b} \ln(R_i/L_i^{\chi}) \right) \\ &+ \frac{q_i(\upsilon_i)}{k o_i} \left(\frac{1-b}{b} \tilde{B}_i - (r + o_i) H_i \right). \end{aligned}$$

This simplified framework of frictional labour markets provides a micro-foundation for the labour force participation equation (10). Specifically, the wage elasticity of labour supply, ϵ, and the elasticity of extensive labour supply to public goods provision ρ_h in the main framework of our paper are thus related as follows:

$$\epsilon = \left(\frac{q_i(\upsilon_i)}{k o_i} \right) \frac{1-\alpha(1-b)}{b(1-\alpha)}; \quad \rho_h = \frac{(1-\alpha)(1-b)}{1-\alpha(1-b)} \tilde{\rho}_h.$$

They are functions of the job finding rate, the sunk cost of vacancy posting, the separation rate, and the workers' Nash bargaining share. The elasticity of labour supply ϵ increases with the local job-finding rate but decreases with the sunk cost of vacancy posting, the exogenous separation rate and the workers' Nash bargaining share. Furthermore, the market frictions, represented by $B_{h|i}$, increase with non-employment benefits, the value of leisure/non-employment, $\tilde{B}_i$, and productivity of worker-firm matches, Z_i (as a proxy for the job finding rate under perfect firm entry) but decrease with match costs, $(r + o_i)H_i$:

$$B_{h|i} = \frac{b(1-\alpha)}{1-\alpha(1-b)} \left(\left(\frac{1-b}{b} \right) \tilde{B}_i - (r + o_i) H_i + \ln Z_i \right).$$

B Online Supplement: Optimal Spatial Policy

In this Supplement we provide further details how the set-up of the social planner problem allows to derive optimal spatial policy instruments. The first-order conditions, to which we refer in this Supplement, are all provided in Appendix A.2 that accompanies the main paper and in this Supplement we refer to their designation and numbering throughout.

Optimal Private Good Consumption - Steps 1 & 2. We first derive workers' optimal private good consumption levels from the planner's problem. By using the first-order condition on the local labour force, equation (A.9), we can re-write the first-order conditions on local consumption of both types of goods as follows:

$$(1-\alpha)\left[\frac{(\epsilon^g-1)\left(1-\xi^g_{h|i,u}\right)}{\epsilon^g-1+\xi^g_{h|i,u}}\right]\left(\mu^g\mathcal{U}'\left(\mathcal{V}^g\right)\mathcal{V}^g+\theta W^g_{i,u}-\theta\sum_{j\in J}\sum_{u'\in M}W^g_{j,u'}\left(\frac{L^g_{j,u'}}{L^g}\right)\right)$$
$$=\left(1-\xi^g_{h|i,u}\right)P_iC^g_{m|i,u}-w^g_{i,u}\left[(1-\alpha)\,\epsilon^g\right]\xi^g_{h|i,u}.$$

$$(1-\alpha)\left[\frac{\epsilon^g\xi^g_{h|i,u}}{\epsilon^g-1+\xi^g_{h|i,u}}\right]\left(\mu^g\mathcal{U}'\left(\mathcal{V}^g\right)\mathcal{V}^g+\theta W^g_{i,u}-\theta\sum_{j\in J}\sum_{u'\in M}W^g_{j,u'}\left(\frac{L^g_{j,u'}}{L^g}\right)\right)$$
$$=\xi^g_{h|i,u}P_iC^g_{h|i,u}+w^g_{i,u}\left[(1-\alpha)\,\epsilon^g\right]\xi^g_{h|i,u}.$$

Next, we substitute the first-order conditions on local population, Eq. (A.10) into these new equations. This yields a system of three equations, which can be uniquely solved for the optimal consumption levels of employed workers solely as a function of the market wage and policy instruments $\{\tilde{t}^g_{s|i,u},\tilde{x}^g_{s|i,u}\}$:

$$P_i\tilde{C}^g_{s|i,u}=\left(1-\tilde{t}^g_{s|i,u}\right)w^g_{i,u}+\tilde{x}^g_{s|i,u} \tag{B.1}$$

$$1-\tilde{t}^g_{s|i,u}=\begin{cases}\frac{(1-\alpha)\theta}{1+(1-\alpha)\theta}+(1-\alpha)\,\epsilon^g\xi^g_{h|i,u}\left(\frac{1}{1-\xi^g_{h|i,u}}-\frac{\theta}{[1+(1-\alpha)\theta]\left[\epsilon^g-\left(1-\xi^g_{h|i,u}\right)\right]}\right) & \text{if } s\in M,\\ \frac{1-\xi^g_{h|i,u}}{\xi^g_{h|i,u}}\left(\frac{(1-\alpha)\theta}{1+(1-\alpha)\theta}-(1-\tilde{t}^g_{m|i,u})\right) & \text{otherwise}\end{cases}$$

$$\tilde{x}^g_{s|i,u}=\begin{cases}\frac{(\epsilon^g-1)(1-\alpha)\left(\mu^g\mathcal{U}'(\mathcal{V}^g)\mathcal{V}^g-\theta\sum_{j\in J}\sum_{u'\in M}\frac{W^g_{j,u'}L^g_{j,u'}}{L^g}+\theta Ex^{NET}_i\right)}{[1+(1-\alpha)\theta]\left[\epsilon^g-\left(1-\xi^g_{h|i,u}\right)\right]} & \text{if } s\in M,\\ \frac{\epsilon^g}{\epsilon^g-1}\cdot\tilde{x}^g_{m|i,u} & \text{otherwise}\end{cases}$$

Optimal Private Goods Consumption Levels as a Function of Observables - Step 3. We substitute out the opportunity cost term $W_{i,u}^{g}$ once again, using the first-order condition on local population in the additive wage subsidy equations.

Note further that the weighted average of aggregate private good consumption is given as follows:

$$\sum_{i\in J}\sum_{u\in M} P_i L_{i,u}^{g} \sum_{s\in h,m} \xi_{s|i,u}^{g} C_{s|i,u}^{g} = \sum_{i\in J}\sum_{u\in M}\left[L_{i,u}^{g} w_{i,u}^{g} \sum_{s\in h,m} \xi_{s|i,u}^{g}\left(1-\tilde{t}_{s|i,u}^{g}\right) + L_{i,u}^{g} \sum_{s\in h,m} \xi_{s|i,u}^{g} \tilde{x}_{s|i,u}^{g}\right]$$

Plugging in the expressions for weighted additive wage subsidies and taxes yields

$$(1-\alpha)\,\mu^{g}\mathcal{U}'\left(\mathcal{V}^{g}\right)\mathcal{V}^{g} = \frac{1}{L_g}\sum_{i\in J}\sum_{u\in M} L_{i,u}^{g}\left[P_i \sum_{s\in h,m} \xi_{s|i,u}^{g} C_{s|i,u}^{g}\right]$$

Note further that total consumption expenditures (on private and public goods) in the economy have to equal total incomes from working and land rents such that

$$\begin{aligned}
&\sum_{g\in G}\sum_{j\in J}\sum_{u'\in M} L_{j,u'}^{g} P_j \sum_{s\in h,m} \xi_{s|j,u'}^{g} C_{s|j,u'}^{g} + \sum_{j\in J} P_j^{R} R_j \\
&= \sum_{g\in G}\sum_{j\in J}\sum_{u'\in M} L_{j,u'}^{g}\left(1-\xi_{h|j,u'}^{g}\right) w_{j,u'}^{g} + \sum_{j\in J}\sum_{u'\in M} h_{j,u'} r_j
\end{aligned}$$

Substituting the expression for marginal utilities $(1-\alpha)\,\mu^{g}\mathcal{U}'\left(\mathcal{V}^{g}\right)\mathcal{V}^{g}$ into the expression for additive wage subsidies and using this last equation, finally yields:

$$\begin{aligned}
\tilde{x}_{m|i,u} = &\frac{1}{\sum_{g\in G} L^{g}\left[\epsilon^{g}-\left(1-\xi_{h|i,u}^{g}\right)\right]/(\epsilon^{g}-1)}\times \\
&\left[\sum_{g\in G}\sum_{j\in J}\sum_{u'\in M}\frac{\left(1-\xi_{h|i,u}^{g}\right)L_{j,u'}^{g} w_{i,u'}^{g}}{1+(1-\alpha)\,\theta} + \left(h_{j,u'} r_j - P_j^{R} R_j\right)\right. \\
&\left. + \sum_{g\in G}\frac{(1-\alpha)\,\theta L^{g}}{1+(1-\alpha)\,\theta}\left(Ex_i^{NET} - \frac{1}{L^{g}}\sum_{j\in J}\sum_{u'\in M} L_{j,u'}^{g} Ex_j^{NET}\right)\right]
\end{aligned} \tag{B.2}$$

as well as

$$\tilde{x}_{h|i,u} = \tilde{x}_{m|i,u} * \frac{\sum_{g\in G} L^{g}\left[\epsilon^{g}-\left(1-\xi_{h|i,u}^{g}\right)\right]/(\epsilon^{g}-1)}{\sum_{g\in G} L^{g}\left[\epsilon^{g}-\left(1-\xi_{h|i,u}^{g}\right)\right]/\epsilon^{g}} \tag{B.3}$$

where we assume that additive wage subsidies do not differ by worker group as in the framework in the main part of the paper, such that $\tilde{x}_{s|i,u}^{g} = \tilde{x}_{s|i,u} \quad \forall g \in G$.

Given that tax rates are solely a function of observable labour force participation rates (see equation (B.1)), optimal transfers to workers, $\tilde{x}_{s|i,u}$, are determined by a vector of variables at the regional level $\{h_{i,u}, L^g_{i,u}, r_i, w^g_{i,u}, \xi^g_{h|i,u}\}$, structural parameters $\{\alpha, \epsilon^g, \zeta^g, \theta, \rho^g_h, \chi\}$ and payments to local governments for public goods provision.

Optimal Public Good Provision - Step 4. Next, we derive optimal public goods provision, given the optimised private goods consumption possibilities for all worker groups and the tax system. In the first step, we re-write the first-order conditions on local public good consumption (equation (A.5)) as follows:

$$\begin{aligned}
&\left[\alpha - \Upsilon^g_{i,u}\right]\left(\mu^g \mathcal{U}'\left(\mathcal{V}^g\right)\mathcal{V}^g + \theta W^g_{i,u} - \theta \sum_{j\in J}\sum_{u'\in M} W^g_{j,u'}\left(\frac{L^g_{j,u'}}{L^g}\right)\right) \\
&= P^R_i \tilde{R}_i / L_i - \alpha \epsilon^g \rho^g_h \xi^g_{h|i,u} w^g_{i,u}.
\end{aligned}$$

Substituting in the first-order conditions on local population $L^g_{i,u}$, equation Eq. (A.10), as well as the optimal consumption levels yields optimised public goods consumption as a function of private goods consumption. Substituting the expressions for the latter and again combining with the first-order condition on population, we derive optimised public goods consumption as follows:

$$\begin{aligned}
\frac{P^R_i \tilde{R}_i}{L_i} &= \left[\alpha - \Upsilon^g_{i,u}\right]\left(\frac{\mu^g \mathcal{U}'\left(\mathcal{V}^g\right)\mathcal{V}^g}{1+(1-\alpha)\theta} + \frac{\theta E x^{NET}_i}{1+(1-\alpha)\theta} - \theta\left(\frac{(1-\alpha)\theta\left(1-\xi^g_{h|i,u}\right)}{1+(1-\alpha)\theta}\right) w^g_{i,u}\right. \\
&+ \frac{\frac{\theta}{L^g}\sum_{j\in J}\sum_{u'\in M} L^g_{j,u'}\left[P_j \sum_{s\in h,m} \xi^g_{s|j,u'} C^g_{s|j,u'} - \left(1-\xi^g_{h|j,u'}\right) w^g_{j,u'} - E x^{NET}_i\right]}{1+(1-\alpha)\theta} \\
&+ \left.\left(\theta\left(1-\xi^g_{h|i,u}\right) + \epsilon^g \rho^g_h \xi^g_{h|i,u}\left[\frac{\epsilon^g - 1 + \xi^g_{h|i,u}}{\epsilon^g - 1 + \xi^g_{h|i,u}\left[1-\epsilon^g \rho^g_h\right]}\right]\right) w^g_{i,u}\right)
\end{aligned}$$

Public Good Provision as a Function of Observables - Step 5. At this point, we again make use of the fact that

$$\mu^g \mathcal{U}'\left(\mathcal{V}^g\right)\mathcal{V}^g = \frac{1}{(1-\alpha)L^g}\sum_{i\in J}\sum_{u\in M} L^g_{i,u}\left[P_i \sum_{s\in h,m} \xi^g_{s|i,u} C^g_{s|i,u}\right]$$

Plugging in and combining with the solutions for private goods consumption, we derive the optimal levels of local public good provision $\tilde{R}_i$ solely as a function of observable variables at the region-gender-sector level (e.g. employment, wages, rents, labour force participation rates, price levels) as well as structural parameters and subsidies to workers:

$$\frac{P_i^R \tilde{R}_i}{L_i} \sum_{g\in G} \sum_{u\in M} \frac{\left(\epsilon^g - 1 + \xi^g_{h|i,u}\right) L^g}{\left(\epsilon^g - 1 + \xi^g_{h|i,u}\left[1 - \epsilon^g \rho^g_{h,R}\right]\right)} = \frac{\alpha}{1-\alpha}$$

$$\left(M \times \left[\sum_{g\in G} \frac{L^g \left[\epsilon^g - \left(1 - \xi^g_{h|i,u}\right)\right]}{\epsilon^g - 1} \cdot \tilde{x}_{m|i,u}\right] + \frac{(1-\alpha)\,\theta \sum_{g\in G}\sum_{u\in M}\left(1 - \xi^g_{h|i,u}\right) L^g w^g_{u|i,u}}{1 + (1-\alpha)\,\theta}\right.$$

$$\left. + \sum_{g\in G}\sum_{u\in M} L^g (1-\alpha)\, \epsilon^g \rho^g_{h,R} \xi^g_{h|i,u} w^g_{u|i,u} \left[\frac{\epsilon^g - 1 + \xi^g_{h|i,u}}{\epsilon^g - 1 + \xi^g_{h|i,u}\left[1 - \epsilon^g \rho^g_{h,R}\right]}\right]\right), \tag{B.4}$$

where we used the fact that aggregate expenditures on private and public goods consumption equals total labour and rent income in the economy and the definition of optimal subsidies to employed workers.

Optimal Public and Private Goods Consumption - Step 6. Given our results from steps 1-3 and the definition of local externalities, the vector of optimal policy instruments $\{\tilde{x}_{s|i,u}, P_i^R \tilde{R}_i\}$ is given by the unique solution to the system of equations (B.2) - (B.4), while optimal tax rates $\tilde{t}^g_{s|i,u}$ are determined by equation (B.1).

C Data and Quantification

C.1 Data

Table C.1 maps the ISIC 4 sectors to the six "market sectors" we use in the quantification of our framework. The first four sectors are tradable, while the last two sectors are non-tradable.

C.2 2011 Census Shock and Fiscal Transfers

This appendix provides details on our identification strategy and additional empirical results.

Institutional Background. Germany's fiscal redistribution scheme uses local population counts to determine transfer allocations across jurisdictions. In 2011, a nationwide Census revealed substantial deviations from official registry-based population projections that had previously been used to calculate fiscal transfers. Figure

Table C.1: ISIC Revision 4 Sector Classification

Sector	ISIC Rev. 4	Description
1. Agriculture	A	Agriculture, Forestry and Fishing
2. Mining and Quarrying	B, D, E	Mining and Quarrying; Electricity, gas, steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities
3. Manufacturing	C	Manufacturing
4. Wholesale/Retail Trade	G - J	Wholesale and retail trade; repair of motor vehicles and motorcycles; Transportation and Storage; Accommodation and food service activities; Information and communication
5. Construction	F	Construction
6. Non-tradable and Non-market Services	K - U	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

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, while sectors 5 and 6 are non-tradable sectors.

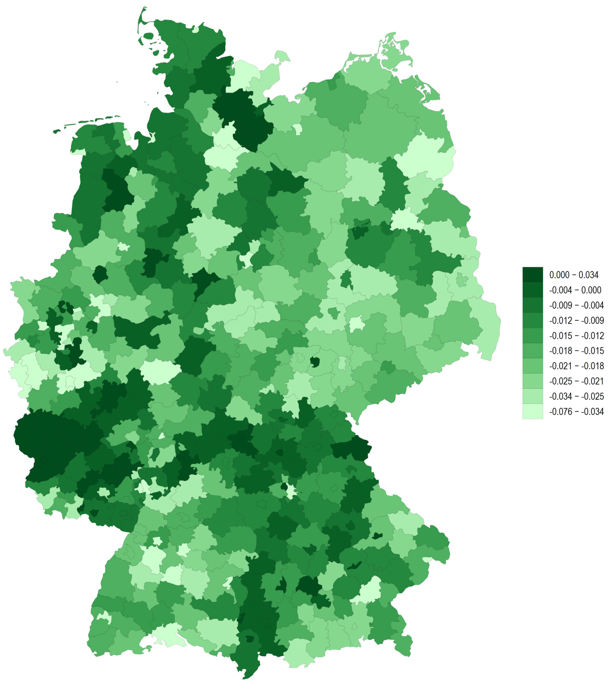
C.1 displays the spatial distribution of Census revisions. These unexpected revisions, ranging from -7.65% to $+3.43\%$, led to permanent changes in local fiscal budgets unrelated to economic conditions.[21]

Empirical Strategy. Following a similar strategy as Helm and Stuhler (2024) and Serrato and Wingender (2016), we compare regions experiencing above-mean Census revisions (treated) to those below (control). A remaining identification concern is the potential correlation between Census count revisions and pre-existing local economic trends. Declining areas might show larger discrepancies between registry and Census counts, potentially confounding our estimates. To address this concern, we adjust the difference-in-differences (DID) regression approach with augmented inverse probability weighting (AIPW). The AIPW approach constructs synthetic control groups by combining outcome regression and treatment models, requiring only one to be correctly specified for consistent estimation (Sant'Anna and Zhao, 2020). Our estimations control for state-specific trends, pre-treatment characteristics, four annual lags of non-employment rates and transfers to account for pre-treatment dynamics (Arkhangelsky et al., 2021).

Additional Estimation Results. We compare pre-treatment characteristics between regions experiencing above-mean Census revisions (treated) and those below

[21] Helm and Stuhler (2024) show that such windfall increases to budgets translate into higher government expenditures, particularly in the short run.

Figure C.1: DISTRIBUTION OF THE 2011 CENSUS SHOCK



Note: The figure plots the spatial distribution of the 2011 Census Shock. The Census Shock is measured as the log difference between local population counts at the end of 2010 and the results of the 2011 Census in May 2011.

the mean (control). Table C.2 documents systematic differences between treated and control regions for several characteristics in our sample. Treated regions show higher wages but lower population and initial fiscal transfers. Moreover, the dynamics of these variables in the pre-treatment period differ between groups. These systematic differences in both levels and pre-treatment dynamics motivate our use of augmented inverse probability weighting (AIPW).

Despite these differences, Figure C.2 confirms the validity of our research design by demonstrating parallel pre-trends in both fiscal transfers and non-employment rates, with clear divergence only after treatment. Panel A shows that treated regions experienced persistently higher fiscal transfers following the Census revision. Panels B and C demonstrate that these increased transfers coincided with sustained reductions in non-employment rates, with stronger effects for female workers.

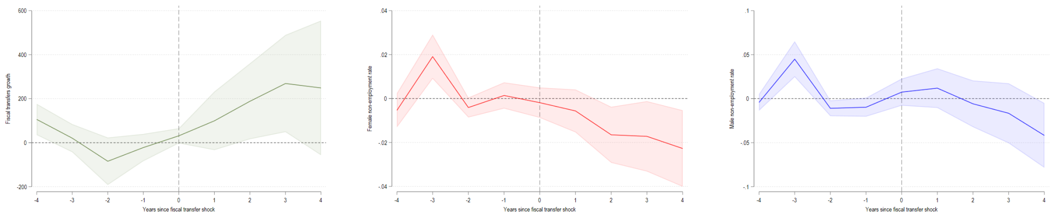
Table C.3 explores treatment effect heterogeneity by local infrastructure access. We construct composite measures of public service availability using principal component analysis. For childcare access, we combine standardized measures of child-

Table C.2: Balance on Pre-treatment Characteristics

	Control	Treated	Difference	SE
GDP per capita	47 138.53	45 146.75	1991.78**	808.80
Working-age population	158 874.39	111 822.88	47 051.51***	6323.59
Wages	34 305.82	35 884.64	−1578.82***	195.08
Net wages	26 960.65	27 834.84	−874.19***	148.61
Net wages, female	28 930.87	29 777.91	−847.04***	145.06
Net wages, male	39 680.77	41 991.38	−2310.61***	255.46
Employment rate	0.71	0.74	−0.03***	0.00
Employment rate, female	0.70	0.71	−0.01***	0.00
Employment rate, male	0.77	0.80	−0.03***	0.00
Non-employment rate, female	0.30	0.29	0.01***	0.00
Non-employment rate, male	0.23	0.20	0.03***	0.00
Fiscal transfers per capita	903.81	659.92	243.89**	121.78
Tax revenues per capita (before redistribution)	9717.25	9664.22	53.03	125.83
Tax revenues per capita (after redistribution)	10 621.05	10 324.14	296.92***	39.55
Gross expenditures per capita	3279.24	3185.93	93.31	72.36
Public debt per capita	2060.77	2378.80	−318.03***	74.87

Note: The table shows the balance on pre-treatment characteristics between control and treated groups. Means and standard errors (SE) are reported. Significant differences are indicated by ** (p ¡ 0.05) and *** (p ¡ 0.01).

Figure C.2: Event Study Estimates



(a) Transfers (b) Female Non-employment (c) Male Non-employment

Note: This figure presents event study estimates for fiscal transfers per capita and (log) non-employment rates by gender. Panel A shows the estimates for fiscal transfers per capita, while Panels B and C display the estimates for female and male non-employment rates, respectively. The results confirm parallel pre-trends between treated and control regions.

care rates for children below 3 years and between 3-5 years. For transport access, we combine standardized measures of distance to public transportation and average travel times to the nearest motorway, airport, and train station. Data comes from the INKAR (2020) database. The results indicate that fiscal transfer shocks following the 2011 Census had the most significant employment effects in regions with limited pre-existing public services, especially in areas lacking adequate childcare infrastructure.

C.3 Identifying Model Fundamentals

In this Supplement, we detail the individual steps necessary to invert the fundamentals of the model (e.g., productivities, amenities, and market frictions) from the structure of the framework. Our strategy for identifying these fundamentals involves

Table C.3: Gender-Specific Impacts of Fiscal Transfers on Employment

	Childcare Access		Transport Access	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
Female Non-employment rate	-0.019**	-0.004	-0.006*	0.005
	(0.009)	(0.010)	(0.007)	(0.111)
Male Non-employment rate	-0.019*	0.008	0.002	0.003
	(0.011)	(0.034)	(0.014)	(0.148)
Observations	4,400	4,400	4,400	4,400
Controls	Yes	Yes	Yes	Yes
State × Year FE	Yes	Yes	Yes	Yes
Pre-treatment characteristics	Yes	Yes	Yes	Yes

Notes: This table reports estimates of heterogeneous effects of Census-induced fiscal transfer shocks on non-employment rates by initial public service access. Childcare access (columns 1-2) combines standardized principal components of childcare rates for children below 3 years and between 3-5 years. Transport access (columns 3-4) combines standardized principal components of distance to public transportation, average travel time to the nearest motorway, airport, and train station. Regions are classified as "Low" or "High" based on pre-treatment median splits of these composite measures. All specifications include controls for log net wages and four annual lags of outcome variables. Standard errors (in parentheses) are clustered at the regional labour market level. + $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

several steps:

1. **Derive model-consistent values $\delta_{i,u}$, $\delta_{i,uu'}$, $\kappa_{i,u}$** The parameters $\delta_{i,u}$ can be identified by the fraction of value added over gross regional output in each region-sector pair:

$$\delta_{i,u} = \frac{\sum_{g \in G}(1 - \xi_{h|i,u}) w^g_{i,u} L^g_{i,u} + r_i h_{i,u}}{\sum_{j \in J} \pi_{ji,u} X_{j,u}},$$

Summing the demand for materials over all regions yields

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

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 producing goods from each sector from the World Input-Output Tables (Timmer et al. (2015)). We assume then that in all regions, the value of materials $u' \in M$ used as inputs, relative to total material inputs, is constant:

$$\delta_{uu'} = \frac{\delta_{i,uu'}}{\sum_{u'\in M}\delta_{i,uu'}} \quad \forall i \in J \quad \text{and} \quad \delta_{i,uu'} = (1-\delta_{i,u})\,\delta_{uu'}.$$

We calibrate the share of value added accruing to workers as

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

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

   Expenditures on land and structures are a fixed share of total wage expenditures:

$$r_i h_{i,u} = \frac{\kappa_{i,u}}{1-\kappa_{i,u}}\sum_{g\in G} w^g_{i,u}L^g_{m|i,u}.$$

3. **Calculate model-consistent expenditure shares $\beta^C_{u'}$ and $\beta^R_{u'}$**

   Aggregate goods markets clear for all sectors, which implies that

$$\begin{aligned}
\sum_{i\in J} X_{i,u} =& \beta^R_u\left[\left(\sum_{i\in J}\sum_{g\in G}\sum_{u'\in M}\left(t^g_{m|i,u'}+\iota_i\right)(1-\xi^g_{h|i,u'})w^g_{i,u'}L^g_{i,u'}\right)\right]\\
&+\beta^C_u\left[\sum_{i\in J}\frac{L_i}{L}\left(\sum_{j\in J}\sum_{u'\in M} r_j h_{j,u'} - \sum_{g\in G}(1-t^g_{h|i,u'})\xi^g_{h|j,u'}w^g_{j,u'}L^g_{j,u'}\right)\right.\\
&\left.+\sum_{i\in J}\sum_{s\in h,m}\sum_{u'\in M}\sum_{g\in G}\left(1-t^g_{s|i,u'}\right)\xi^g_{s|i,u'}w^g_{i,u'}L^g_{s|i,u'}\right]\\
&+\sum_{i\in J}\sum_{u'\in M}\frac{\delta_{i,u'u}}{\delta_{i,u'}\left(1-\kappa_{i,u'}\right)}\sum_{g\in G}(1-\xi^g_{h|i,u'})w^g_{i,u'}L^g_{i,u'}.
\end{aligned}$$

   With wage and employment data, as well as parameter values for ι_i and regional tax rates t_i, as well as $\delta_{i,u}$,$\kappa_{i,u}$ and $\delta_{i,uu'}$ obtained from identification step 1, we solve for model-consistent expenditure shares $\{\beta^C_u, \beta^R_u\}$. [22]

[22] We assume local governments do not consume housing but distribute expenditures like workers across the remaining sectors. This assumption allows us to better fit private expenditure to observable housing expenditure shares in Germany.

4. **Calculate total expenditures**
Goods market clearing in all regions and sectors implies that,

$$\begin{aligned}X_{i,u} =&\beta_u^R \left[\left(\sum_{g\in G} \sum_{u'\in M} \left(t^g_{m|i,u'} + \iota_i \right) (1-\xi^g_{h|i,u'}) w^g_{i,u'} L^g_{i,u'} \right) \right] \\ &+ \beta_u^C \left[\frac{L_i}{L} \left(\sum_{j\in J} \sum_{u'\in M} r_j h_{j,u'} - \sum_{g\in G} (1-t^g_{h|i,u'}) \xi^g_{h|j,u'} w^g_{j,u'} L^g_{j,u'} \right) \right. \\ &\left. + \sum_{s\in h,m} \sum_{u'\in M} \sum_{g\in G} \left(1 - t^g_{s|i,u'} \right) \xi^g_{s|i,u'} w^g_{i,u'} L^g_{s|i,u'} \right] \\ &+ \sum_{u'\in M} \frac{\delta_{i,u'u}}{\delta_{i,u'} \left(1-\kappa_{i,u'}\right)} \sum_{g\in G} (1-\xi^g_{h|i,u'}) w^g_{i,u'} L^g_{i,u'},\end{aligned} \tag{C.5}$$

which we solve for using the model-consistent expenditure shares $\{\beta_u^C, \beta_u^R\}$ from identification step 4.

5. **Calculate relative unit cost shares $\tilde{\lambda}_{i,u}$ for all tradable goods**
Substituting the model-consistent expressions for trade shares as well as the calculated values for total expenditure into the equations for value added we get

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

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.

6. **Compute sector-specific price levels for all tradable goods**
Substituting relative unit costs $\tilde{\lambda}_{j,u}$ we solve for the ideal cost indices $P_{i,u}$:

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

where $\sum_{n\in J} \left(\lambda_{n,u}\right)^{\nu_u}$ are sector-specific constants to be determined by normalisation. We choose a model-consistent normalisation on aggregate sector-specific cost indices: $P_u \equiv \sum_{i\in J} P_{i,u}\pi_{i,u} = 1$, that is we define sector-specific cost aggregates as a weighted average of region-sector-specific costs and normalise 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 sector u, that accrues to region-i expenditures. Applying the normalisation, we solve for the sector-specific constants and subsequently calculate ideal cost indices:

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

Unit costs in levels are therefore determined as

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

7. **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 $P_{i,nt} = \Gamma(\gamma_{nt})^{\frac{1}{1-\sigma}}\lambda_{i,nt}$. Finally, we normalise aggregate price levels and unit costs to the numéraire such that $\sum_i P_i \equiv \bar{P} = 1$.

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

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

Substituting relative productivity $\tilde{Z}^g_{i,u} \equiv \frac{Z^g_{i,u}}{\sum_{g\in G}Z^g_{i,u}}$ and applying the fact that relative productivity $\tilde{Z}^g_{i,u}$ sums to unity in all region-sector pairs allows identifying them solely in terms of observable average wages and market employment:

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

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

$$Z_{i,u}^{g}=\tilde{Z}_{i,u}^{g}\left[\frac{D_{i,u}}{\lambda_{i,u}}\left(r_i^{\kappa_{i,u}}\left[\sum_{g\in G}\left(\frac{\tilde{Z}_{i,u}^{g}}{w_{i,u}^{g}}\right)^{\sigma^g-1}\right]^{\frac{1-\kappa_{i,u}}{1-\sigma^g}}\right)^{\delta_{i,u}}\prod_{u'\in M}\left[P_{i,u'}\right]^{\delta_{i,uu'}}\right]^{\frac{1}{\delta_{i,u}\left(1-\kappa_{i,u}\right)}}.$$

9. **Ensure goods market clearing in non-tradable sectors**
   Identification step 5 ensures goods market clearing in all regions and tradable sectors since unit costs are identified from model-consistent trade flows. In contrast, we use data on observable price levels in non-tradable sectors for quantification, which may not ensure goods market clearing initially. We, therefore, gradually adjust the parameters $\delta_{i,u}, \delta_{i,uu'}$ across regions and non-tradable sectors such that they ensure goods market clearing also in non-tradable sectors. The loop works as follows:

   - Follow identification steps 1-8, given initial guesses for $\delta_{i,u}, \delta_{i,uu'}$ in all regions and sectors
   - Calculate trade flows implied by guesses of unit costs, $X_{i,u}$ and trade costs
   - Use guesses for unit costs and intermediate cost inputs to compute the total value of intermediate goods production
   - Evaluate whether local production equals total demand
   - Adjust the parameters $\delta_{i,u}, \delta_{i,uu'}$, re-do all the steps above until goods market clearing is ensured

10. **Compute preferences as compensating differentials to labour supply**
    Given sector-specific unit cost levels as well as data on wages $w_{i,u}^{g}$, tax rates, public expenditure and employment rates, overall preference shifters $A_i^g \exp\left[-\mu_{m|i,u}^{g}\right]$ are recovered as the residual to observable labour supply: [23]

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

    To split the two preference components, we regress the overall preference shifter on region fixed effects for all worker groups to identify amenities and region-

[23] Since preference shifters are identified only up to scale, we normalize the first cell (J=1,G=1,M=1) to unity such that the preference terms in all other regions, sectors and groups are identified relative to this cell.

sector-specific participation costs separately. Thus $\bar{A}_i^g = A_i^g L_i^{-\zeta^g}$, with $A_1 = 1$ for both worker groups.

11. **Compute preference shifters for the home market**
Finally, we use the structural parameter estimates $\{\epsilon^g, \rho_h^g, \alpha\}$ and non-employment rates to recover the home-market-specific preference shifters, such that

$$\mathcal{B}_{s|i,u}^g = \left(\xi_{h|i,u}^g\right)^{\frac{1}{\epsilon^g}} \left(\frac{I_{m|i,u}^g}{I_{h|i,u}^g}\right)^{1-\alpha} \left(\left[\frac{R_i}{L_i^X}\right]^{\rho_h^g}\right)^{\alpha}.$$

Finally, we split preference shifters into participation costs and home-market-preferences, such that $\exp\left[B_{h|i,u}^g\right] = \mathcal{B}_{s|i,u}^g \exp\left[-\mu_{m|i,u}^g\right]$ and normalize all preference components to ensure the requirement $\exp\left[B_{h|i,u}^g\right] = 1$ holds.

D Counterfactual Appendix

In this Appendix we provide further details on the implementation of our counterfactuals and additional results on local and aggregate outcomes.

D.1 Implementation

D.1.1 Randomizing Spatial Policies

Monte Carlo Study. Conditional on the initial distribution of fiscal policies, counterfactual equilibria are unique as long as congestion forces outsize agglomeration forces. Yet, there may be a multiplicity of equilibria for different initial sets of policies. Since we are interested in the global maximum that is achievable for the German economy, we further explore this multiplicity of equilibria by varying the spatial distribution of initial policies and, consequently, the starting point for the implementation of social planner policies.

We randomly draw $N = 10,000$ different sets of policies, $\mathcal{V}_0^P = \{\tilde{t}_{s|i,u}^g, \tilde{x}_{s|i,u}^g, \tilde{E}_i\}$, and then solve for the values of all endogenous variables that are consistent with these policies in general equilibrium, given structural parameters and exogenous economy fundamentals.

Randomization strategy. A social planner chooses a vector of taxes, regional transfers and wage subsidies, $\mathcal{V}_0^P = \{\tilde{t}_{s|i,u}^g, \tilde{x}_{s|i,u}^g, \tilde{E}_i\}$ as a function of local wages, labour force participation, population and rents, such that they satisfy all general equilibrium conditions as detailed in the Appendix A.2 of the main paper. For our

Monte Carlo study we randomise this vector, which allows to solve for $N = 10,000$ different initial equilibria. In the following, we provide details on the randomization procedure.

1. Randomly draw tax rates for employed workers, $\tilde{t}^g_{m|i,u}$, from a uniform distribution in bounds $(0,1)$ for all places, sectors and worker groups. We normalise simulated tax rates such that their average equals the mean in the data (at around $t = 0.4$). This ensures that the aggregate share of public goods, relative to private goods, is still comparable to the observed one for the year 2014.

2. Non-employed workers receive a fraction $o^g_{i,u}$ of after-tax wage income. We randomly draw this fraction from a uniform distribution in bounds $(0,1)$ for all places, sectors and worker groups. Taxes on non-employed workers follow as $\tilde{t}^g_{h|i,u} = 1 - (1 - \tilde{t}^g_{m|i,u}) \cdot o^g_{i,u}$.

3. Calculate model-consistent rent income from all locations, net of non-employment payments:

$$\mathcal{K} = \sum_{i \in J} \sum_{u \in M} \sum_{g \in G} \left(\frac{\kappa_{i,u}}{1 - \kappa_{i,u}} \left(1 - \xi^g_{h|i,u}\right) w^g_{i,u} L^g_{i,u} - (1 - \tilde{t}^g_{h|i,u}) \xi^g_{h|i,u} w^g_{i,u} L^g_{i,u} \right)$$

4. Calculate aggregate government income that can be redistributed across local governments and workers:

$$E = \sum_{i \in J} \sum_{u \in M} \sum_{g \in G} \tilde{t}^g_{m|i,u} \left(1 - \xi^g_{h|i,u}\right) w^g_{i,u} L^g_{i,u} + \mathcal{K}$$

5. Calculate total funds available for public goods expenditure: $\alpha \cdot E$.[24]

6. Randomly allocate αE to different locations: $\tilde{E}_i = \frac{\text{share}^P_i}{\sum_{i \in J} \text{share}^P_i} \cdot \alpha E$, where [25]

$$\text{share}^P_i = \frac{\sum_{u \in M} \sum_{g \in G} L^g_{i,u}}{\sum_{i \in J} \sum_{u \in M} \sum_{g \in G} L^g_{i,u}} \cdot \tilde{\iota}_i; \quad \text{and} \quad \tilde{\iota}_i \sim U(0.1, 1.9)$$

7. Calculate total funds to be distributed as (additive) wage subsidies: $(1 - \alpha) \cdot E$

[24]Note: Under Cobb-Douglas preferences α is the preferred ratio of public to private goods.

[25]Our choice of randomisation of government transfers and wage subsidies incorporates three objectives: (i) ensures that there is at least some public good provision/wage subsidies in all locations initially, (ii) ensures that all funds are spent on public or private goods in either of the J locations and (iii) highly-populous locations get more funds for consumption of both goods.

8. Randomly allocate wage subsidies across locations, sectors and worker types. First, we calculate the (random) shares of the total funds that accrue to all workers:

$$\text{share}_i^S = \frac{L_{i,u}^g}{\sum_{i \in J} \sum_{u \in M} \sum_{g \in G} L_{i,u}^g} \cdot \tilde{\iota}_{i,u,S}^g; \quad \text{and} \quad \tilde{\iota}_{i,u,S}^g \sim U(0.5, 1.5)$$

Second, we determine the subsidies that accrue to all workers:

$$\tilde{x}_{u|i,u}^g = \frac{\text{share}_{i,u,S}^g}{\sum_{i \in J} \sum_{u \in M} \sum_{g \in G} \text{share}_{i,u,S}^g} \cdot (1-\alpha) \cdot E / L_{i,u}^g$$

Lastly, we normalise subsidies such the total amount of subsidies equals the funds used for private wage subsidies:

$$\tilde{x}_{u|i,u}^g = \frac{\tilde{x}_{i,u}^g}{\sum_{i \in J} \sum_{u \in M} \sum_{g \in G} \left(\tilde{x}_{i,u}^g L_{i,u}^g \right)} \cdot (1-\alpha) \cdot E \quad \text{and} \quad \tilde{x}_{u|i,u}^g = \tilde{x}_{h|i,u}^g$$

D.1.2 Initial equilibria

When solving for the initial spatial equilibrium in each Monte Carlo iteration, we start from the observed equilibrium in 2014, implement the N sets of spatial policies and solve for the counterfactual values of all endogenous variables in general equilibrium. In each iteration, we solve for new levels of wages, employment and LFP rates and use them to adjust the (random) policies: we keep tax rates ($\tilde{t}_{s|i,u}^g$), random transfer rates ($\tilde{\iota}_i$) and subsidy shares ($\tilde{\iota}_{i,u,S}^g$) constant, but update public/private funds, government expenditures and wage subsidies with the new wages, local employment and labour force participation rates.

A spatial equilibrium is found when all markets clear, the random policies are implemented, and the aggregate resource constraint is satisfied. The outcomes are N different spatial equilibria that are determined by (random) fiscal policies, exogenous characteristics of the German economy in 2014 and the same set of structural parameters.

Details on Implementation. In the following, we provide further details how inverted model fundamentals $\{\bar{A}_i^g, B_{h|i,u}^g, H_i, \bar{Z}_{i,u}^g\}$ and model parameters $\{\alpha, \epsilon^g, \zeta^g, \eta^g, \theta, \kappa_{i,u}, \nu_u, \rho_h^g, \sigma, \tau_{ij,u}, \chi\}$ can be combined with a counterfactual set of spatial policies $\{t_{s|i,u}^g, x_{s|i,u}^g, \iota_i\}$ to solve for a counterfactual set of endogenous variables $\mathbf{V} = \{E_i, h_{i,u}, I_{s|i,u}^g, L_{i,u}^g, L_{s|i,u}^g, P_{i,u}, r_i, w_{i,u}^g, X_{i,u}, \lambda_{i,u}, \pi_{ij,u}\}$. For computational quickness, we split the loop into two components: An inner loop and an outer loop, that updates labour force participation rates. In Algorithm 1, we use pseudo-code to highlight the workings of the inner loop.

In the outer loop, we update labour force participation rates with the model-consistent endogenous variables, determined in the inner loop. Particularly, we solve for non-employment rates (Eq. (10)) and use this to restart the inner loop with new inputs.

Local Maxima. In this counterfactual, we search for the fiscal policies that maximize overall welfare and evaluate their aggregate impact on the economy. We start from the initial equilibria that are determined by the random fiscal policy sets. Next, we derive and implement the policy instruments according to Proposition 2 in the main paper and solve for a counterfactual general equilibrium. Since the optimal policies are a function of endogenous variables, we re-adjust them in each iteration after having solved for new values of these variables in each iteration. Conditional on exogenous economy characteristics, structural parameters and initial policies, we thus find $N = 10,000$ local welfare maxima, induced by implementing the optimal rules for taxes, transfers and subsidies.

Global Maximum. Out of the set of local maxima we pick the one that leads to the largest increase in overall welfare relative to the *baseline* German economy in the year 2014 and with the empirically observable tax and transfer rates.

Algorithm 1: Numerical solution algorithm - Inner Loop

Given values for primitives $\{\bar{A}^g_i, B^g_{h|i,u}, H_i, \bar{Z}^g_{i,u}\}$, first guess for $\xi^g_{h|i,u}$ and model parameters $\{\alpha, \epsilon^g, \zeta^g, \eta^g, \theta^g, \kappa_{i,u}, \nu_u, \rho^g_h, \sigma, \tau_{ij,u}, \chi\}$, define a counterfactual set of spatial policies $\{t^g_{s|i,u}, x^g_{s|i,u}, \iota_i\}$ that solve for a set of endogenous variables $\mathbf{V} = \{E_i, h_{i,u}, I^g_{s|i,u}, L^g_{i,u}, L^g_{s|i,u}, P_{i,u}, r_i, w^g_{i,u}, X_{i,u}, \lambda_{i,u}, \pi_{ij,u}\}$

Set convergence parameter $\kappa \in (0,1)$

Set precision rule to govern deviation between guesses and model solution.

Set maximum number of iterations to $maxiter$ and $count = 1$

Guess values of $P_{i,u}$ $w^g_{i,u}$ and $L^g_{i,u}$

while $count < maxiter$ **do**

- Solve for aggregate expenditures, $\sum_{j \in J} \pi_{ji,u} X_{j,u}$, from labour demand condition.
- Use aggregate expenditures to solve for expenditures on materials, $M_{i,uu'}$, and rents, $\{r_i h_{i,u}, r_i\}$, from their respective market clearing conditions
- Solve for $X_{i,u}$ by using final goods market clearing.
- Solve for $\lambda_{i,u}$ from the definition of unit costs.
- Solve for new trade shares π_{ij}, using updated unit costs.
- Then compute new values of initial (or updated) guesses:
- Compute $P^{new}_{i,u}$ from updated unit costs. Normalise aggregate price level in the economy to $\sum_{i \in J} P^{new}_i L_i / L \equiv \bar{P} = 1$
- Compute $L^{g,new}_{i,u}$ from labour supply condition and using updated prices.
- Compute $w^{g,new}_{i,u}$ from labour demand condition and using updated levels of employment.
- Check deviation between guesses and model solution

$$target1 = round(abs(w^g_{i,u} - w^{g,new}_{i,u}), precision)$$
$$target2 = round(abs(L^g_{i,u} - L^{g,new}_{i,u}), precision)$$
$$target3 = round(abs(P_{i,u} - P^{new}_{i,u}), precision)$$

- **if** $target1 == 0$ & $target2 == 0$ & $target3 == 0$ **then**
  - break;
- **else**
  - Update initial guesses or updated values of $P_{i,u}$ $w^g_{i,u}$ and $L^g_{i,u}$:

$$w^{g,up}_{i,u} = \kappa w^g_{i,u} + (1-\kappa) w^{g,new}_{i,u}$$
$$L^{g,up}_{i,u} = \kappa L^g_{i,u} + (1-\kappa) L^{g,new}_{i,u}$$
$$P^{up}_{i,u} = \kappa P_{i,u} + (1-\kappa) P^{new}_{i,u}$$

  - Use updated values and re-iterate

$$w^g_{i,u} = w^{g,up}_{i,u}, L^g_{i,u} = L^{g,up}_{i,u}, P_{i,u} = P^{up}_{i,u}$$

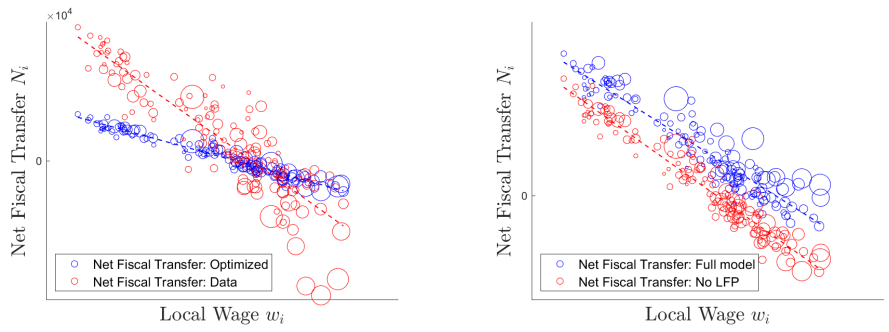
- Compute other endogenous variables (e.g. quantities) as needed.

Result: Equilibrium values of $\mathbf{V}$, given initial guess for $\xi^g_{h|i,u}$

D.2 Additional Results

Optimal Transfers and Redistribution. In Figure D.1 we compare the optimized level of redistribution across different versions of our framework. Panel (a) underscores the insight that a social planner would redistribute less funds into low-wage locations compared to the observed transfer system - even in a model with full employment ("No LFP"). Yet, the correlation of net fiscal transfers with wages is stronger in this model version, compared to their relationship in our full model framework (Panel (b)). Abstracting from the LFP, one, therefore, overestimates the optimal level of redistribution. The relevant conditions behind this insight are also discussed in theory section 4.3 of the main paper.

Figure D.1: OPTIMIZED REDISTIRBUTION - IMPACT OF LFP CHANNEL



(a) Redistribution ("No LFP")

(b) Comparing redistribution between models

Notes: Panel (a) of this Figure displays net fiscal transfers (see Definition 2) against local wages for two different scenarios: (i) optimized policy instruments when abstracting from the LFP channel ($\epsilon^g \to \infty$) and (ii) observed German public finance system in 2014 ("Data"). Panel (b) plots optimized net fiscal transfers (i) in our full model and (ii) in the "No LFP" scenario. The size of the marker is proportional to local labour market size.

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