Düsseldorf Institute for Competition Economics

DISCUSSION PAPER

No 322

Fiscal Transfers in the Spatial Economy

Marcel Henkel,
Tobias Seidel,
Jens Suedekum

September 2019

HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF

d|u|p düsseldorf university press

IMPRINT

DICE DISCUSSION PAPER

Published by

düsseldorf university press (dup) on behalf of
Heinrich-Heine-Universität Düsseldorf, Faculty of Economics,
Düsseldorf Institute for Competition Economics (DICE), Universitätsstraße 1,
40225 Düsseldorf, Germany
www.dice.hhu.de

Editor:

Prof. Dr. Hans-Theo Normann
Düsseldorf Institute for Competition Economics (DICE)
Phone: +49(0) 211-81-15125, e-mail: normann@dice.hhu.de

DICE DISCUSSION PAPER

ISSN 2190-9938 (online) – ISBN 978-3-86304-321-6

Fiscal Transfers in the Spatial Economy

Marcel Henkel

University of Duisburg-Essen

Tobias Seidel

University of Duisburg-Essen, CRED and CESifo

Jens Suedekum[‡]

DICE, CEPR and CESifo

September 2019

Abstract

Many countries shift substantial public resources across jurisdictions to mitigate spatial economic disparities. We use a general equilibrium model with multiple asymmetric regions, labor mobility, and costly trade to carve out the aggregate implications of fiscal transfers. Calibrating the model for Germany, we find that transfers indeed deliver smaller disparities across regions. This comes at the cost of lower national output, however, because activity is diverted away from core cities and towards remote areas with low productivity. But despite this output loss, national welfare may still increase, because the transfer scheme countervails over-congestion in large cities.

JEL-Classification: F15, R12, R13, R23.

Keywords: Fiscal equalization, regional transfers, migration, spatial economics

[‡]Corresponding author: Düsseldorf Institute for Competition Economics (DICE), Heinrich-Heine-University Düsseldorf, Germany; E-mail: suedekum@dice.hhu.de
The authors thank Matthew Kahn (the editor), three anonymous referees, Treb Allen, Costas Arkolakis, Yashar Blouri, Thiess Büttner, Hartmut Egger, Peter Egger, Maximilian von Ehrlich, Yasusada Murata, Johannes Rincke, Frederic Robert-Nicoud, Daniel Sturm and various seminar audiences for helpful comments and suggestions on previous drafts. All errors are solely our responsibility.

1 Introduction

Many countries conduct spatial development policies targeted at economically lagging regions within their territory. Place-based policies often take the form of discretionary spending by higher-order government layers, such as the Federal level, in order to subsidize investment or job creation in designated recipient areas.[1] Examples include enterprise zones in the United States or structural funds in the European Union.

But those regional policies are just one possible instrument how government can affect the spatial economy. An equally, if not more, important mechanism are fiscal transfers.[2] This policy re-distributes tax revenue from areas with high financial capacity to poorer jurisdictions, and thus effectively allows recipient regions to offer more public goods than they otherwise could. In the empirical part of this paper, we focus on Germany and estimate that a remarkable total volume of 53.5 billion Euro worth of transfers is shifted across jurisdictions every year. This includes the Federal fiscal equalization scheme which allocates tax revenue between the 16 States and the Federal level (*Länderfinanzausgleich*), several lower-tier schemes which provide additional equalization across municipalities within States, and various discretionary grants from higher- to lower-level government layers. To set this into perspective, the amount of fiscal transfers within Germany is more than twice as large as all EU structural funds taken together, and it dwarfs the amount that is payed on classical development policies by the German Federal government.[3]

Despite this prevalence of fiscal transfers, surprisingly little is known about their implications. How do they affect aggregate economic activity and the distribution of population and income across space? What is their impact on productivity and welfare at the national level? How do they shape regional migration flows? To shed light on these questions, we set up and quantify a general equilibrium model with multiple asymmetric regions, labor , costly interregional trade, and inter-jurisdictional fiscal transfers. We calibrate the model, taking into account taxes and transfers as observed in (or recovered from) the data. In a counterfactual analysis, we then simulate how the equilibrium would change if Germany were to abandon all transfers completely. In this hypothetical scenario, local public goods are financed solely by taxing local economic activity, but there are no more transfers across jurisdictions. Comparing this counterfactual to the actual equilibrium allows us to provide quantitative answers to the questions how, and through which channels, fiscal transfers affect the spatial economy.

[1] The theoretical rationale for place-based policies is discussed by Kline and Moretti (2014) and Glaeser and Gottlieb (2008). Neumark and Simpson (2014) summarize the empirical literature. Specific policies have been evaluated, among others, by Busso, Gregory and Kline (2013), Becker, Egger and Ehrlich (2010) and Ehrlich and Seidel (2018). Recent contributions by Austin, Glaeser and Summers (2018) and Rodriguez-Pose (2018) discuss those policies in the context of the recent rise in populist vote shares in lagging regions.

[2] See Blöchliger et al. (2007) for an overview of fiscal transfer schemes across OECD countries.

[3] The main instrument, labeled *Gemeinschaftsaufgabe Regionale Wirtschaftsstruktur (GRW)*, is similar to the US enterprise zones program, and amounts to an annual volume of only 1.5 billion Euro.

Such a quantitative approach is needed, because the welfare implications of fiscal transfers are not clear-cut from a purely theoretical point of view. On the one hand, by shifting resources from rich to poor places, transfers may distort incentives and induce some workers or firms to locate in regions that they otherwise would not have chosen (Kline and Moretti, 2014). These mis-allocations may be particularly severe when recipient areas have low levels of productivity, or when they are remotely located so that transport losses in interregional trade are exacerbated. The fiscal transfers may therefore reduce aggregate output at the national level, because they shift economic activity away from core cities (Hsieh and Moretti, 2019). On the other hand, the spatial economy might be affected by various externalities that individuals do not take into account when making location decisions. For instance, individuals ignore their impact on others that is transmitted via local price index effects or through different agglomeration and congestion forces. A laissez-faire equilibrium without transfers may therefore be characterized by an inefficient spatial structure, and in particular, by cities that are "too large" from a social point of view (Henderson 1974; Albouy et al. 2019). By reducing over-congestion in cities, the fiscal transfers may therefore actually mitigate rather than exacerbate mis-allocations. We consider some stylized examples of our model and show that welfare implications are indeed ambiguous. Transfers are detrimental in some constellations, but beneficial in other cases. To investigate the welfare effects of fiscal transfers in practice, we therefore take our model to the data.

This quantification is challenging, because the rules and details of the German equalization schemes are complicated and span over several governmental layers (Federal, States and local municipalities). No official statistics are available for net transfer rates of local jurisdictions. To construct empirical proxies, we exploit information on the volumes of generated taxes and available public funds at the local level in the year 2010. Our approach assigns taxes and expenditures to the 141 German labor market regions (*Arbeitsmarktregionen*), which are defined to minimize cross-regional commuting flows. The transfers that we recover from the data account for fiscal equalization schemes within and between Federal States, as well as the allocation of public funds across government layers. The numbers suggest that the total volume of re-distribution is substantial, and amounts to 53.5 billion Euro per year or 10.2 percent of the aggregate tax revenue. Local labor markets comprising the largest and most productive cities in the West are the biggest net contributors. Frankfurt comes out on top with a transfer rate of 13.3 percent of local gross domestic product (GDP), which is equivalent to 4,000 Euro per inhabitant that is paid to other jurisdictions via fiscal transfers. The main recipients are poor and remote locations, often located in East Germany, which receive support of up to 23.1 percent of local GDP.

In our counterfactual scenario, where all fiscal transfers are abolished, we observe a major migration wave out of the former recipient and towards the former donor regions. In total, we calculate that roughly 2.7 million people would change their local labor market in the transition to a new long-run spatial equilibrium. Some East German regions would lose almost one quarter of their population, while big cities like Frankfurt or Munich would substantially grow. As the induced migration is from less to more productive regions, we observe substantial gains in aggregate output and productivity at the national level. In our benchmark specification, we calculate that abolishing transfers raises average labor productivity by 3.4 percent and real GDP per capita by 1.8 percent. By retaining economic activity in the periphery, fiscal transfers therefore limit productivity and income dispersion across space. But this comes at the cost of lower national output and productivity.

When turning to national welfare, however, we find a different pattern. In our baseline counterfactual, welfare even mildly decreases by 0.06 percent when transfers are abolished. In alternative specifications we sometimes obtain welfare gains, but they are consistently an order of magnitude smaller than productivity and output gains. The reason is that the former donor regions are already over-congested in the initial equilibrium. When transfers are switched off, additional migration into those crowded cities is induced, and this makes the problem of congestion externalities even worse. In other words, abolishing fiscal transfers may increase national GDP but not welfare.

Notice, however, that this does not mean that the current level of fiscal transfers in Germany is the best of what could be achieved. Indeed, we find that the *optimal* transfer scheme (taking current taxes as given) actually implies somewhat *less* fiscal equalization across local labor markets, and somewhat *smaller* transfers than what we currently observe. In other words, current fiscal transfers are better than no transfers, but still the prevailing level of equalization may be too large from a national welfare point of view.

Our paper relates to various strands of literatures. First, we add to a recent line of research which introduces policy instruments into quantitative economic geography models with labor mobility. In particular, Fajgelbaum, Morales, Suárez Serrato, and Zidar (2019) analyze tax heterogeneity across US federal states and find that a harmonization of state taxes would alleviate misallocations and raise welfare at the national level. Our analysis focuses on fiscal transfers, since states and municipalities have very little discretion over tax rates in Germany, but we also consider endogenous local tax responses.

A second line of research focuses on the optimal design of fiscal transfer schemes. Our paper builds on the class of recently developed quantifiable spatial general equilibrium models and explicitly accounts for interregional trade costs (in contrast to Albouy, 2012, and Albouy et al., 2019). We also consider the design of an optimal transfer scheme, similarly as in Blouri and Ehrlich (2017) or in Fajgelbaum and Gaubert (2018).

Third, Hsieh and Moretti (2019) study labor mis-allocation due to housing supply restrictions in the US. In our model, fiscal equalization also implies lower productivity and output at the national level, but it potentially also mitigates over-crowding in highly productive cities. Aggregate welfare implications may thus be different.

The paper is organized as follows. We introduce the spatial model with fiscal transfers in Section 2 and illustrate key economic mechanisms in Section 3. Section 4 explains how we quantify the model for Germany. The counterfactual analysis is presented in Section 5 before we conclude in Section 7.

2 A quantitative geography model with fiscal transfers

We consider an economy consisting of N regions. The economy is populated by a mass $\bar{L}$ of homogeneous workers, who are (imperfectly) mobile across regions. Governments in every region collect income taxes to provide local public goods, and a fiscal transfer scheme reallocates resources across jurisdictions.

2.1 Preferences

Similarly as in Fajgelbaum, Morales, Suárez Serrato and Zidar (2019), we assume that households in region i derive utility from consumption of a private good $C(i)$ and public services $G(i)$ according to the following Cobb-Douglas preferences, where $0 < \gamma < 1$:

$$U(i) = u(i) \cdot \left(\frac{G(i)}{L(i)^{\eta}} \right)^{\gamma} \cdot C(i)^{1-\gamma} \tag{1}$$

The parameter $\eta \in [0; 1]$ governs the degree of rivalry in public services, with $\eta = 0$ capturing the case of a pure local public good and $\eta = 1$ the case of fully rival per-capita transfers.[4] The term $u(i)$ represents a local amenity including fixed features like scenery or climate, but also endogenous local characteristics such as congestion or housing prices. Notice our specification also allows us to account for idiosyncratic locational preferences, as we discuss in greater detail in Section 2.6 below.

2.2 Production technologies

Every region i produces a unique variety of a differentiated intermediate good under perfect competition using labor as the sole input. Locations differ in productivity, such that every worker produces $A(i)$ units of this good. A final good $Q(i)$ is assembled from the continuum of intermediates according to the following CES aggregator:

$$Q(i) = \left[\int_N q(n, i)^{\frac{\sigma-1}{\sigma}} dn \right]^{\frac{\sigma}{\sigma-1}}. \tag{2}$$

Here, $q(n, i)$ denotes the quantity of the variety produced in location n and used for assembly in location i, and $\sigma > 1$ represents the elasticity of substitution between intermediates.

[4]This modeling strategy, which accounts for congestion in public goods provision, goes back to the work by Flatters, Henderson and Mieszkowski (1974).

We assume that $\tau(n,i) \geq 1$ units must be sent from n for one unit to arrive in i, and we abstract from intra-regional transport costs ($\tau(i,i) = 1$).

Final goods are not traded across regions, and assembly has no extra costs. The price of the final good in location i is therefore given by

$$P(i) = \left[\int_N p(n,i)^{1-\sigma} dn \right]^{\frac{1}{1-\sigma}}. \tag{3}$$

This final good $Q(i)$ can either be used directly for private consumption $C(i)$, or by local governments to provide public services $G(i)$. Thus, we have $Q(i) = C(i) + G(i)$. The aggregate demand for the variety from n in location i is given by

$$q(n,i) = \frac{p(n,i)^{-\sigma}}{P(i)^{1-\sigma}} E(i), \tag{4}$$

where $E(i)$ denotes overall (private and public) expenditure in i.[5]

2.3 Profit maximization and inter-regional trade

As the differentiated varieties are produced under perfect competition, prices equal effective marginal costs including transport costs. That is, $p(n,i) = \tau(n,i)w(n)/A(n)$ for the intermediate produced in n and sold in i, where $w(n)$ is the wage in n. Using those prices in (3) and (4) we obtain total sales from n to i as follows,

$$X(n,i) = \left(\frac{\tau(n,i)w(n)}{A(n)P(i)} \right)^{1-\sigma} E(i), \tag{5}$$

and the CES price index in location i becomes:

$$P(i) = \left[\int_N \left(\frac{\tau(n,i)w(n)}{A(n)} \right)^{1-\sigma} dn \right]^{\frac{1}{1-\sigma}}. \tag{3'}$$

2.4 Taxes, public spending, and fiscal transfers

We now describe the public sector in this economy. Income is taxed at rate rate $t(i)$ in region i, which generates an overall tax revenue equal to $t(i)w(i)L(i)$. Assuming that the public budget is balanced, the level of local public goods is thus given by $G(i) = t(i)w(i)L(i)/P(i)$ when there are no inter-regional transfers. When a fiscal transfers scheme is in place, every region is either a net recipient of public funds from other jurisdictions, or respectively, a net donor. Net receipts are denoted as $\theta(i)w(i)L(i)$, where the transfer rate relative to local aggregate income is positive ($\theta(i) > 0$) for recipient and

[5] This setup, where private and public goods are combined from the same set of intermediate inputs, follows Fajgelbaum, Morales, Suárez Serrato and Zidar (2019).

negative ($\theta(i) < 0$) for donor regions. Given those transfers, the effective budget that is available for local public goods provision in region i is given by

$$G(i) = [t(i) + \theta(i)]\, w(i)L(i)/P(i), \tag{6}$$

and aggregate spending becomes $E(i) = (1 + \theta(i))w(i)L(i)$.

This specification of the public sector is kept as simple as possible, but it is flexible enough for our purpose of taking the model to the data. Three comments are in order about our setup. First, the model abstracts from any optimizing behavior of governments in the setting of tax rates $t(i)$ or transfer rates $\theta(i)$, including strategic considerations such as horizontal tax competition.[6] Instead, we consider $t(i)$ and $\theta(i)$ as being exogenously given and recover them from the data. Starting from those observed *actual* choices, we then study the economic effects of fiscal transfers in a counterfactual analysis. Second, we abstract from a Federal government (or any other vertical structure) and from national public goods. In the empirical application below, however, we consider all layers of the public sector in Germany, and break down Federal and State tax revenue to the local level. This approach also allows us to include tax revenue from other sources (such as value-added or corporate profits) other than income taxes as featured in our model. Third, we abstract from progressive tax schedules and dead-weight losses of income taxation. However, although individuals supply labor inelastically, we will see later that they respond to regional differences in tax and transfer rates through migration. Local governments therefore do face a mobile tax base, as individuals choose their locations endogenously.

2.5 Indirect utility

Using (2)–(6) in (1), we can write indirect utility in region i as follows:

$$W(i) = u(i) \cdot \frac{w(i)}{P(i)} \cdot L(i)^{\gamma(1-\eta)} \cdot \left[(t(i) + \theta(i))^{\gamma} (1 - t(i))^{1-\gamma} \right]. \tag{7}$$

The first two terms in (7) show that regions with better amenities $u(i)$ and higher real wages $w(i)/P(i)$ tend to be more attractive locations for households. The third term indicates that larger regions are more desirable when there is some non-rivalry in public services (if $\eta < 1$), because more inhabitants can share public facilities.[7] Finally, the fourth term shows that an inflow of fiscal transfers (an increase of $\theta(i)$) increases indirect utility, ceteris paribus, because it allows governments to expand local public goods.

[6] Local governments in Germany have indeed little autonomy over tax rates, as less than 9 percent of tax revenue comes from sources over which they have any discretion. See Section 4 for details. In Section 6.1, however, we do consider endogenous local tax responses to changes in transfer rates.

[7] In other words, local public goods provision establishes one agglomeration force in our model that is increasing in γ and decreasing in η.

2.6 Micro-foundations of agglomeration and dispersion forces

Apart from the sharing of local public goods, there is an additional agglomeration force in our model that operates via the local productivity level and thus local wages. More specifically, we follow Allen and Arkolakis (2014) and assume that $A(i)$ is given by:

$$A(i) = \bar{A}(i)L(i)^{\alpha}, \quad \text{with } \alpha \geq 0. \tag{8}$$

Here, $\bar{A}(i)$ represents a location-specific exogenous productivity, and the positive impact of $L(i)$ on $A(i)$ captures additional agglomeration economies such as knowledge spillovers. The strength of this force is measured by the elasticity α, which relates to a large empirical literature (e.g., Ciccone and Hall 1996, Combes and Gobillon 2015) that has estimated the impact of population size (or density) on productivity in various contexts.

The dispersion force in our model works through the common local amenity term $u(i)$. It, too, contains an exogenous component $\bar{u}(i)$, capturing scenery or climate, and an endogenous part that is negatively linked to local population size as follows:

$$u(i) = \bar{u}(i)L(i)^{-\beta}, \quad \text{with } \beta \geq 0, \tag{9}$$

where β governs the strength of that endogenous dispersion force. This simple notation is a short-cut for several possible micro-foundations of local congestion effects.

Housing costs. For example, it may capture higher housing prices in larger cities. Allen and Arkolakis (2014, p. 1091) have formally established this isomorphism. First, defining $1-\delta$ as the income share spent on a fixed local factor, and setting $\beta_0 = (1-\delta)/\delta$ renders this model isomorphic to Helpman (1998) and Redding (2016). The price of the immobile factor increases when workers migrate into a region, and this congestion externality (higher housing prices) as captured by β_0 runs through (9) in our setup.[8] Besides housing prices, β_0 may also capture related urban costs such as worse traffic jams, longer commuting times, and more noise in larger cities.

Location tastes. Moreover, we can add individual location tastes as another congestion force. In their theory appendix, Allen and Arkolakis (2014) show how to incorporate this feature, which is often used in the literature, into their framework and the isomorphism they establish carries over to our model. In short, adding location tastes effectively leads to an increase of β, i.e., stronger congestion forces.

More specifically, suppose indirect utility (7) not only includes the amenity term $u(i)$ that is common to all individuals living and working in i, but an additional multiplicative

[8] This micro-foundation is then also related to a large empirical literature on higher housing costs in larger cities. See, for example, Combes, Duranton and Gobillon (2019).

term $v(i,\omega)$. That term represents idiosyncratic location tastes of individual ω for region i. It is the realization of a random variable, which is drawn from a Frechet distribution with shape parameter k, similarly as in Redding (2016). Using (9) in (7), we can rewrite indirect utility as follows: $W(i) = \bar{u}(i) \cdot w(i)/P(i) \cdot L(i)^{-\beta+\gamma(1-\eta)} \cdot \left[(t(i)+\theta(i))^{\gamma}(1-t(i))^{1-\gamma}\right]$. Applying the argument by Allen and Arkolakis (2014), we have $\beta = \beta_0 + 1/k$, where β_0 captures the congestion externality from housing, and $(1/k)$ the strength of individual location tastes. Intuitively, those preferences make workers less mobile across regions, as their location choices are now also affected by idiosyncratic tastes and not only by prices and amenities that are valued equally by all individuals. Formally, this force materializes in the model *as if* the common congestion forces were stronger ($\beta > \beta_0$).

To keep our model parsimonious, we do not take a stance on specific micro-foundations. Instead we use the congestion force (9) as a flexible reduced form, which may capture housing plus other urban costs, as well as location tastes. Similarly, the specification (8) represents various agglomeration externalities that have been studied in the literature, besides the sharing of local public goods that is inherent in our model.

2.7 Equilibrium

A competitive equilibrium in this economy is defined by the following four conditions:

1. **Labor market clearing.**
$$\int_N L(i)di = \bar{L} \tag{10}$$

2. **Goods market clearing.** Total labor income in region i, $w(i)L(i)$, must equal region $i's$ total sales to all locations $n \in N$:
$$w(i)L(i) = \int_N X(i,n)dn, \tag{11}$$
where $X(i,n)$ is given by (5) and includes fiscal transfers across regions.[9]

3. **Balanced public budget.** The total amount of transfers paid must equal the total amount received:
$$\int_N \theta(i)w(i)L(i)di = 0. \tag{12}$$
Moreover, every local government spends its available budget entirely on local public goods, $[t(i)+\theta(i)]\, w(i)L(i) = G(i)$, as imposed above in (6).

[9]Note that fiscal transfers imply trade imbalances in equilibrium. Donor regions produce more than they consume, and thus run a current account surplus (also see Dekle, Eaton and Kortum, 2007). To see this formally, recall that total expenditure must equal local spending plus total imports, so $E(i) \equiv (1+\theta(i))w(i)L(i) = \int_N X(n,i)dn$. Comparing this expression with (11), we observe that the difference between exports and imports is given by $-\theta(i)w(i)L(i)$, while $\int_N(-\theta(n)w(n)L(n))dn = 0$.

4. **Utility equalization.** Finally, free of labor ensures that utility is equalized across all locations. That is, $W(i) = W(j) = W \;\; \forall i, j \in N$.

To solve for the equilibrium, we first substitute utility (7) and bilateral exports (5) into the goods-market clearing condition (11) to obtain

$$\begin{aligned} L(i)^{1-\alpha(\sigma-1)} w(i)^{\sigma} =& W^{1-\sigma} \bar{A}(i)^{\sigma-1} \int_N \tau(i,n)^{1-\sigma} \bar{u}(n)^{\sigma-1} \Theta(n)^{\sigma-1} \\ & (1+\theta(n))\, w(n)^{\sigma} L(n)^{1+(\sigma-1)[-\beta+\gamma(1-\eta)]} dn, \end{aligned} \tag{13}$$

where $\Theta(n) \equiv (t(n)+\theta(n))^{\gamma}(1-t(n))^{1-\gamma}$. Second, combining (7) and (3') allows us to rewrite the price index equation as follows

$$\begin{aligned} w(i)^{1-\sigma} L(i)^{(1-\sigma)[-\beta+\gamma(1-\eta)]} =& W^{1-\sigma} \Theta(i)^{\sigma-1} \bar{u}(i)^{\sigma-1} \\ & \int_N \tau(n,i)^{1-\sigma} \bar{A}(n)^{\sigma-1} w(n)^{1-\sigma} L(n)^{\alpha(\sigma-1)} dn. \end{aligned} \tag{14}$$

Using data on tax rates $t(i)$, transfer rates $\theta(i)$, bilateral trade costs $\tau(i,n)$, wages $w(i)$, and population sizes $L(i)$ in the system (13) and (14) allows us to solve the model for the exogenous productivities $\bar{A}(i)$ and amenities $\bar{u}(i)$ up to a positive constant.[10]

In their model, Allen and Arkolakis (2014) have shown that $\beta > \alpha$ is a sufficient condition to ensure existence and uniqueness of a stable equilibrium, although equilibria may also exist if that condition is not satisfied. In our framework with local public goods and fiscal transfers, the respective sufficient condition reads as:

Condition 1: $\beta \geq \alpha + \gamma(1-\eta)$.

In words, the congestion force parameterized by $\beta \geq 0$ is at least as strong as the sum of the standard agglomeration force ($\alpha \geq 0$) and the sharing of public facilities ($\gamma(1-\eta) \geq 0$). Notice that the net agglomeration externality is then negative, $\alpha + \gamma(1-\eta) - \beta \leq 0$, so that an inflow of population into region i reduces indirect utility $W(i)$, ceteris paribus.

In our baseline quantification, we will choose parameter values for α, β, γ and η such that this condition is satisfied. Those parameter choices are informed by available empirical estimates from the literature on agglomeration and dispersion forces. But we will also consider constellations where Condition 1 does *not* hold, in which case our model may still exhibit equilibria.[11] We come back to those issues in the quantitative part below.

[10] Allen and Arkolakis (2014) have shown that for $\theta(n) = 0 \;\; \forall n$ and $\Theta = 1$ it is possible to collapse the above system of two nonlinear integral equations into one equation providing a direct link between $w(i)$ and $L(i)$ for each location. In this case the equilibrium can be obtained as the uniform limit of a simple iterative procedure for specific parameter restrictions.

[11] Notice that local income and expenditure are not equivalent in our model. We therefore could not establish the formal conditions for existence, uniqueness and stability of equilibrium over the complete parameter range as in Figure 1 of Allen and Arkolakis (2014), but we resort to a numerical approach.

3 The impact of fiscal transfers: Examples

Before turning to the quantification we briefly illustrate our model with simple stylized examples. In all cases we start from a scenario without fiscal transfers, and then introduce them in order to highlight their various economic impacts.

3.1 Income and size differences

Consider a setting with identical exogenous amenities $\bar{u}(i) = \bar{u}$, equal tax rates ($t(i) = t$) and without transport costs across all N regions ($\tau_{ij} = 1\ \forall i, j$). We split regions into two groups with exogenous productivities $\bar{A}(i) = A_1$ in $n_1 \in [0; N/2]$ and $\bar{A}(i) = A_2 \leq A_1$ in $n_2 \in (N/2; N]$. In an initial equilibrium without fiscal transfers, all regions within a group are symmetric since geography plays no role. Moreover, the productive regions in group 1 are larger than the less productive ones in group 2 (i.e., $L_1 \geq L_2$). They also have higher wages ($w_1 \geq w_2$), higher output ($Q_1 \geq Q_2$), higher spending ($E_1 \geq E_2$), and more public services ($G_1 \geq G_2$). Those regional gaps are larger, the higher is the exogenous productivity difference $\mathcal{A} \equiv A_1/A_2 \geq 1$.[12] Yet, regions in group 1 have lower overall amenities ($u_1 \leq u_2$) due to the endogenous congestion forces.

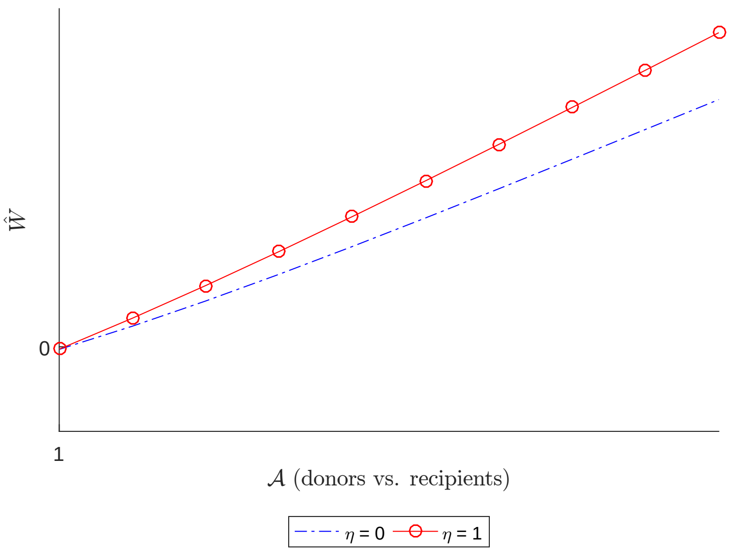
Now we introduce a small fiscal transfer from the rich to the poor regions, i.e., $\mathrm{d}\theta_2 w_2 L_2 = -\mathrm{d}\theta_1 w_1 L_1 > 0$. This transfer triggers migration towards group 2, because it allows for more local public goods there, which in turn makes the regions in group 2 relatively more attractive. As a consequence, the regional productivity gap partly closes in the new equilibrium, because inward migration endogenously raises productivity in group 2 and outward migration lowers it in group 1. At the aggregate level, however, the economy suffers an output and productivity loss, because the transfer effectively induces individuals to relocate from productive to unproductive regions.

Utility is, of course, equalized across all regions in the old and in the new equilibrium. But the common *level* of equalized utility in the economy (denoted $W = W_1 = W_2$) will differ before and after the small fiscal transfer is introduced. In Figure 1, we plot the percentage change in W resulting from the fiscal transfer against the size of the initial productivity gap $\mathcal{A}$. We observe that the transfer leads to an overall welfare gain in the economy, which is increasing in the magnitude of $\mathcal{A}$.

Why do fiscal transfers raise overall welfare in this example, although it lowers aggregate output and productivity? The intuition is that regions in group 1 are inefficiently large in the initial equilibrium. To see this, notice that single households neglect the impact of their private location decisions on other agents, which are transmitted via the

[12] Notice that the overall productivity difference between the regions is even larger than $\mathcal{A}$ due to the endogenous agglomeration externality (8).

Figure 1: Fiscal transfers between productive and unproductive regions



Notes: The figure illustrates the welfare implications of introducing a fiscal transfer scheme. We rule out trade costs to isolate the effect of productivity (and thus income) differences between regions. The figure shows the association between the percentage change in welfare, $\hat{W}$, and the relative exogenous productivity parameter of donors versus recipients, $\mathcal{A} \equiv \bar{A}_1/\bar{A}_2 \geq 1$. We plot the results for $\eta = 0$ and $\eta = 1$ to highlight the importance of the rivalry in consumption of the local public good.

local externalities including the price index, and migrate until average utilities are equalized ($W_1 = W_2$). A welfare-maximizing social planner, by contrast, would allocate workers so as to equate marginal utilities $\partial W_1/\partial L_1 = \partial W_2/\partial L_2$, and thereby fully internalize all externalities (also see Albouy et al. 2019).[13] Recalling that our model features a *negative* net agglomeration externality, since the congestion effect outweighs the sum of agglomeration effects, this implies that the *optimal* size of the regions in group 1 is smaller than their equilibrium size. That is, regions in group 1 are too large while those in group 2 are too small from a social point of view, and this problem is more severe the higher is $\mathcal{A}$.

The small fiscal transfer that we consider in our thought experiment partly offsets this distortion. It does, in general, not implement the optimal allocation in this economy. However, given that the transfer is arbitrarily small, we can be sure that it moves the equilibrium closer to the optimum by triggering private incentives to move to group 2. Thereby it reduces the problem of over-congestion in the large regions in group 1.[14]

Finally, notice from Figure 1 that the aggregate welfare gain from fiscal transfers is increasing in η, the degree of rivalry of local public goods. This is because the net

[13]These authors compare equilibrium and optimal allocations in an urban system with heterogeneous sites and without transport costs. Our current example also assumes freely tradable goods, and is therefore a special case of their general model.

[14]For this example, one can verify that welfare W is hump-shaped, with a unique optimum θ^* such that $W(\theta)$ is monotonically increasing in $\theta \in (0, \theta^*)$ (see Figure 1) and monotonically decreasing for $\theta > \theta^*$. Thus, $\mathrm{d}W/\mathrm{d}\theta > 0$ at $\theta = 0$. We return to the issue of optimal transfers in the quantitative analysis.

agglomeration externality, $\alpha + \gamma(1-\eta) - \beta \leq 0$, is less negative with a pure public good ($\eta = 0$) than with rival per-capita transfers ($\eta = 1$). The initial equilibrium is less over-congested, hence, the transfer tackles only a smaller problem in the economy.

3.2 Trade costs and geography

Our second example focuses on trade costs. We place a discrete number of N locations at equal distances along a unit line, and assume that overall trade costs τ are proportional to the distance of shipment.[15] Obviously, regions in the middle of the line have a more favorable geography than regions on the edge. If exogenous productivities and amenities were the same everywhere, these central locations would thus be larger and pay higher wages in equilibrium (also see Allen and Arkolakis, 2014).

To focus on geography instead of size and income differences, which were discussed in the previous example, we impose different assumptions. In particular, we set the exogenous $\bar{u}(i)$ and $\bar{A}(i)$ such that initial population sizes $L(i)$ and wages $w(i)$, and therefore local GDPs, are the same everywhere in the initial equilibrium. In other words, regions become more attractive and productive towards the edges of the line, and this compensates for the unfavorable geography which materializes in a higher price index. The higher is τ, the stronger are the required compensating differentials for equal regional sizes and incomes.

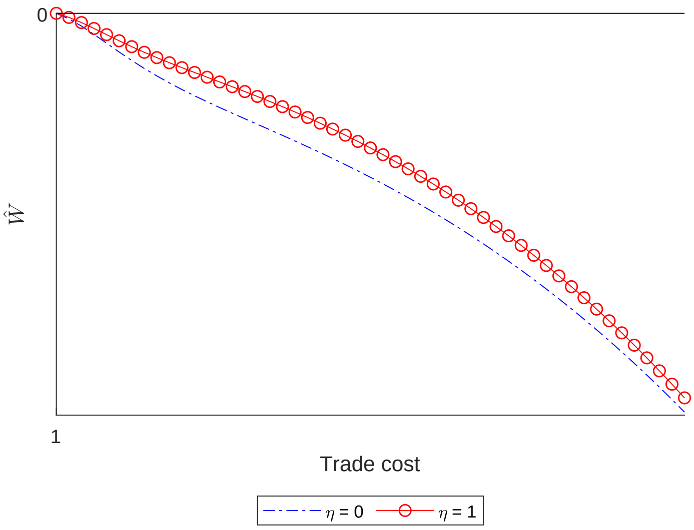
Starting from this scenario, we now introduce a small fiscal transfer that shifts resources from the center towards the periphery, in proportion to individual positions on the line. Again, this triggers migration away from the donors and towards the recipients, so that more economic activity moves towards the edges. This, in turn, exacerbates transport losses as more output is shipped over longer distances. As before, utility is equalized across regions in the old and in the new equilibrium, before and after the transfer.

Figure 2 illustrates the change in the economy-wide welfare level W for different levels of trade costs. When transport is costless ($\tau \rightarrow 1$), fiscal transfers cause a welfare loss. All regions are identical ex-ante in the initial equilibrium, because there are no geographical disadvantages that need to be compensated by exogenous productivity or amenity differences. Then, shifting resources via the transfer scheme only leads to an inefficient concentration of workers in the recipient regions, which face the negative net agglomeration externalities. At higher levels of τ, there are stronger ex-ante differences in regional characteristics $\bar{u}(i)$ and $\bar{A}(i)$ which are held constant in the counterfactual scenario. But the overall welfare implications of fiscal transfers remain negative, and the magnitude is even stronger the higher is τ because of the exacerbated transport losses.

In words, using fiscal transfers to shift economic activity to remote locations causes a welfare loss, even if those locations are inherently more productive and attractive.

[15] That is, trade costs are τ from one end of the line to the other, τ/N between any two nodes, etc.

Figure 2: Fiscal transfers between core and periphery



Notes: The figure illustrates the welfare consequences of introducing a small fiscal transfer scheme. We assume that regions have the same GDP before transfers, but differ with respect to transport costs. Locations in the core have lower transport costs than locations in the periphery. The figure plots the reaction of welfare in percent, $\hat{W}$, after a small fiscal transfer from the central to the peripheral locations has been introduced. We plot the results for $\eta = 0$ and $\eta = 1$ to highlight the importance of the rivalry in consumption of the local public good.

3.3 Discussion

Summing up, the examples suggest that fiscal transfers may lead to lower output and productivity at the national level, if they induce people to locate in unproductive regions. They may also amplify transport losses when they provide incentives for households to move to remote areas, thereby causing a welfare loss at the aggregate level. On the other hand, fiscal transfers may also tackle the problem of over-congestion that is inherent in our framework. The overall welfare implications of a fiscal transfer scheme are, thus, ambiguous a priori and hinge on specific parameter constellations.

In reality, all those aspects are likely to operate in parallel. Our aim is, therefore, to conduct a quantitative analysis of an economy with multiple asymmetric regions and transport costs, in order to shed light on the various economic effects of fiscal transfers. More specifically, we calibrate the model using taxes and transfers as observed in (or recovered from) the data, and in a counterfactual analysis, we then entirely shut down all fiscal transfers. This exercise allows us to evaluate if the current status quo delivers higher or lower welfare than a hypothetical scenario without *any* fiscal equalization. Afterwards, we also discuss the *optimal* transfer scheme, and evaluate if the current status quo exhibits “too much” or “too little” redistribution relative to this optimum.

4 Quantification: Fiscal transfers in Germany

To bring our model to the data, we consider the case of Germany which operates a pronounced fiscal transfer scheme that shifts a substantial amount of resources across jurisdictions. Our calibration is for 2010, which is the most recent year for which all necessary information is available. We start with an overview of the institutional background before introducing the data and discussing parameter choices and estimation.

4.1 Institutional background

Political power in Germany is divided between the Federal government, 16 State governments (the Länder), and roughly 11,000 municipalities. Each of these authorities is autonomous and largely independent with respect to budgetary issues, but at the same time responsible for carrying out specific tasks on the expenditure side of the public budgets. The revenue side is formed by a combination of independent taxes set by the different government layers, and to the largest extent by the sharing of joint taxes.

Table 1: Tax revenues, 2010

	in billion Euro	in percent
Joint	372.9	70.3
Federal taxes and tariffs	97.8	18.4
State	12.1	2.3
Municipality	47.8	9.0
Sum	530.6	100

Source: German Statistical Office (2011a).

Table 1 shows that the aggregate tax revenue summed up to 530.6 billion Euro in 2010, which is equivalent to 20.6 percent of GDP. Joint taxes account for approximately 70 percent of this amount, with income taxes (32 percent) and the value-added tax (VAT, 34 percent) being by far the most important categories. Those revenues are shared between the three broad government layers according to specific formulas.[16] Additional taxes come on top whose revenues accrue exclusively to only one layer. Here, the Federal level accounts

[16]For example, income taxes are shared with shares 42.5 percent for the Federal, 42.5 percent for the State, and 15percent for the local level. For the VAT, the respective shares are 52 percent, 45.5 percent, and 2.5 percent. See Federal Ministry of Finance (2016) for further details.

for 18.4 percent (e.g., excise duties), States for 2.3 percent (e.g., inheritance taxes), and the local level for 9 percent of the overall revenue. The latter include real property and excise business taxes (*Gewerbesteuer*), which are the only cases where municipalities have some discretion in setting tax rates.

Starting from this initial distribution across the three broad layers of government, tax revenue must be allocated to the single States and municipalities. This is done according to a complicated set of rules that includes population and income shares, as well as various fiscal equalization schemes. Their constitutional basis is Article 72 of the German Constitution, which states that living conditions should be "equivalent" across the country. Both the formula-based Federal equalization scheme (*Länderfinanzausgleich, LFA*), and the municipal schemes within the single States (*Kommunaler Finanzausgleich, KFA*) are specific institutional frameworks derived from this goal.

Both schemes essentially organize the distribution of revenues from joint taxes, coupled with additional fiscal grants from higher- to lower-level government layers as well as horizontal transfers between jurisdictions on the same layer. All detailed rules are summarized in official documents by the German Federal Ministry of Finance (2015, 2016) and analogous documents by the State Ministries. Rather than repeating them here, we describe in the next subsection how we break down tax revenue to the local level and thereby back out the effective degree of fiscal transfers from official tax data.

4.2 Measuring fiscal transfers

To bring our model to the data, we compute local tax revenues before and after redistribution (and hence net transfers) for every municipality ι, aggregate these variables to local labor markets i and relate them to these areas' GDPs to obtain average tax and transfer rates $t(i)$ and $\theta(i)$. This type of information is, unfortunately, not readily available from an administrative source. We therefore need to add some structure to the data, in order to construct empirical proxies.

Tax revenue before redistribution. A key data source for the first step is provided by the German Statistical Office (2011a).[17] Each municipality is entitled to keep a certain percentage of income taxes (15 percent), VAT revenues (around 2 percent) and excise business taxes (varies between municipalities). Combining the absolute amounts of these taxes that are directly attributable to municipalities allows us to uncover the respective total volume of tax income in these categories. To this we add the local taxes that each municipality can keep entirely, and we are able to assign more than 70 percent of aggregate German tax revenue to the local level with this approach. The remaining 30 percent

[17]The specific statistics are called Fachserie 14-4 (Steuerhaushalt) and Fachserie 14-10 (Realsteuervergleich), and Bruttoeinnahmen der Gemeinden (gross income of municipalities).

comprise the exclusive Federal and State taxes, and the corporate taxes which are shared between the Federal and the State level. We allocate the origin of those revenues across municipalities according to their shares in directly attributable tax income, as previously described. This captures the idea that municipalities with higher VAT and income tax revenue are characterized by higher economic activity in general, which implying higher revenues also from other taxes. Finally, dividing tax revenues by local GDP as reported by the Federal Statistical Office yields average tax rates.

Tax revenue after redistribution. Second, we compute local public budgets after redistribution. Here we directly draw on information from the Federal Statistical Office, which publishes data on municipal tax budgets including transfers from other jurisdictions.

The remaining task is to allocate the tax budgets of the upper layers, the Federal and the State level, to the municipalities. We do this by using information about the States' tax budgets after redistribution, and assign this amount to municipalities according to population shares. This allocation by population shares captures the idea that citizens have similar fiscal needs that require similar public funds per capita.[18] We proceed in an analogous way for the remaining Federal tax budget. Combining collected taxes from step one, and the available public budgets from step two finally delivers net transfers per municipality that we can relate to local GDP to obtain transfer rates.

Aggregation of municipalities to local labor markets. Conducting our analysis at the level of 11,000 municipalities would not be sensible, both computationally and because those small-scaled administrative units are not economically meaningful regions. In particular, there are substantial commuting flows which are not explicitly featured in our model. Practically, local GDP would then only be a rough proxy for the local tax base, since income is taxed at the place of residence rather than at the workplace.[19]

Instead, we will conduct our analysis at the level of 141 German local labor markets (LLMs, *Arbeitsmarktregionen*), which are roughly comparable to *commuting zones* (CZs) in the United States. Those LLMs are not administrative units, but they are defined economically in order to minimize cross-regional commuting flows. By working with those spatial units, we thereby come as close as possible to the setup of our model, which assumes that workplace and residence region coincide for every individual.

To move up to this level, we aggregate tax revenues and net transfers of all municipalities ι that belong to local labor market i, and then repeat the computations for the tax revenue before and after redistribution as described above. This, in turn, given us a local tax rate $t(i)$ and a local transfer rate $\theta(i)$, expressed relative to local GDP. Hence-

[18]Population data are taken from German Statistical Office (2011b).

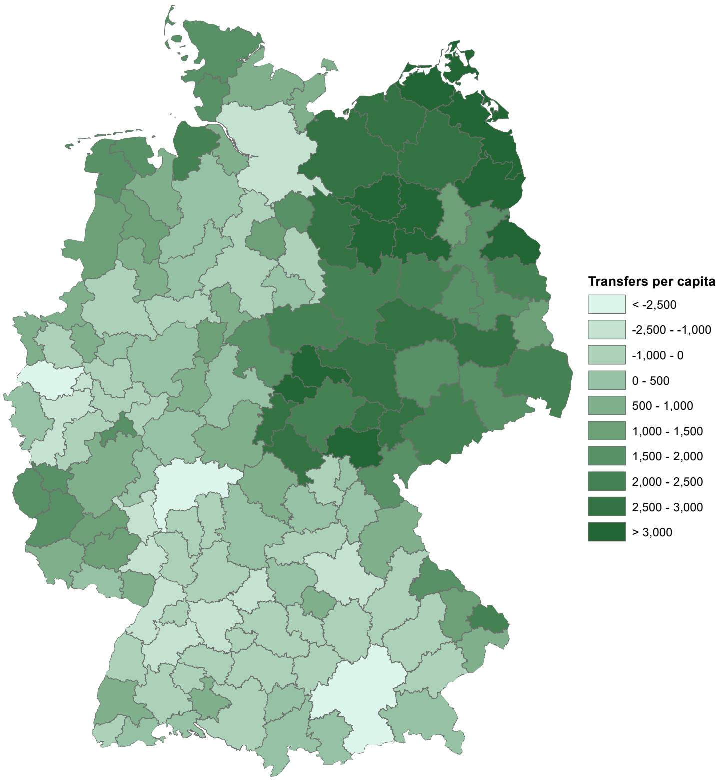
[19]Especially the large cities are characterized by large net inflows of commuters from adjacent regions, and local GDP thus overestimates the tax base in rich urban locations.

forth, when using the subscript i, we thus refer to those local labor markets and call them interchangeably simply a "region".[20]

4.3 Descriptive overview of fiscal transfers

Figure 3 visualizes the per-capita fiscal transfers for all German local labor markets. Darker colors indicate stronger net fiscal receipts, i.e., donor regions are shown in lighter colors. As can be seen, the large German cities turn out to be major net contributors.[21] Frankfurt comes out on top, with approximately 4,000 Euro net donations per-capita, followed by Munich where the respective value is 3,400 Euro. By contrast, peripheral regions (especially in former East Germany) are the main recipients. Here, annual per-capita public transfers exceed 3,000 Euro in some cases.

Figure 3: Per-capita transfers (in Euro)



Notes: Darker areas indicate recipients, bright areas donors.

Panels (a) and (b) of Figure 4 illustrate that the transfer rates $\theta(i)$ are correlated with local wages and population sizes. Net donors are indicated by blue crosses, while red

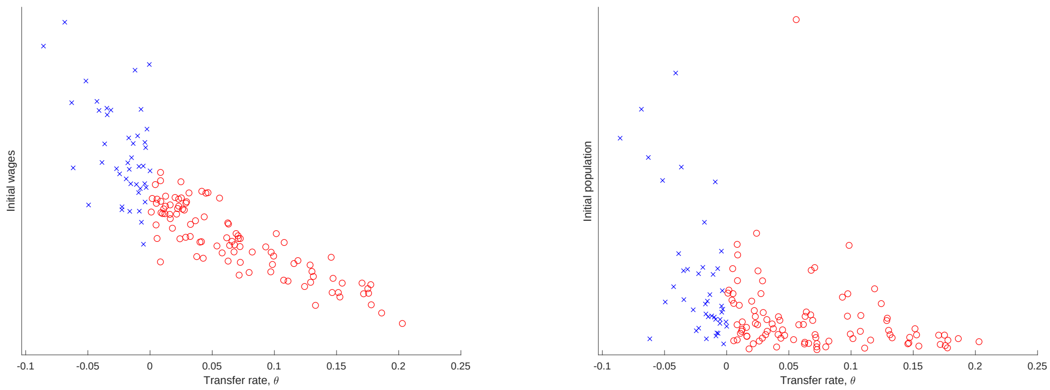
[20]As a robustness check, we have also considered the 401 German NUTS3-region (*Landkreise*) as alternative spatial units. Those are higher-order local administrative units comprised of several municipalities. However, they are not defined according to economic criteria such as commuting flows. Detailed results for our counterfactual analysis using those spatial units can be found in the working paper version of this article, see Henkel, Seidel and Suedekum (2018). They are similar to our main results reported here.

[21]See Appendix Figure A.3 for a map of population density and GDP per capita across German local labor markets.

circles indicate net recipient regions. We observe that high-income regions are net donors, that is $\theta(i) < 0$. More populated regions also tend to be net donors, although Berlin stands out as the major outlier, because it has the largest population but still receives fiscal transfers of around 5.6 percent of its local GDP.[22]

Figure 4: RELATIONSHIP OF WAGES AND POPULATION WITH THE TRANSFER RATE

(a) Wages, $w(i)$ (b) Population, $L(i)$



Notes: Panel (a) links wages to transfer rates $\theta(i)$. Panel (b) plots the relationship of population with the transfer rate $\theta(i)$. Note that donors have a negative transfer rate $\theta < 0$ and are marked by crosses (in blue). Recipients are identified by positive transfer rates and are marked by circles (in red).

With this information at hand, we can also calculate the total amount of fiscal transfers that was shifted across local labor markets in 2010. Specifically, recalling that net donations must equal net receipts by construction, we can sum up the absolute terms $\sum_{i=1}^{141} |w(i)L(i)\theta(i)|/2$ in order to construct a measure for the overall magnitude of fiscal transfers in Germany. This yields a considerable amount of approximately 53.5 billion Euro, or 10.0 percent of the aggregate tax revenue.

Notice that this amount is substantially larger than officially documented figures for the Federal equalization scheme (LFA) as reported by the German Ministry of Finance. In Appendix Table A1, we illustrate the single steps of this scheme, which sum up to a transfer volume of only 26.5 billion Euro that is shifted across States. Our calculations show, however, that the actual volume of fiscal transfers in Germany is even larger, because we also take into account transfers across regions *within* States.[23]

[22]The discrepancy between donors and recipients with respect to population and per-capita income implies that paid transfers are lower relative to local GDP than received transfers. The average level of θ is -0.02 for donors and 0.07 for recipients.

[23]When using the 401 NUTS3-regions instead of the 141 local labor markets as the spatial units, we obtain an even larger total transfer volume that is shifted across jurisdictions in every year, namely 65.0 billion Euro, which is equivalent to 12.4 percent of aggregate tax revenue. Notice that this overall volume may still be seen as a lower bound, because it still abstracts from transfers across municipalities within NUTS3-regions. Moreover, there may be additional (explicit or implicit) fiscal redistribution via other public budgets, e.g. the social security system, which is not featured in our analysis.

4.4 Parameter choices and estimation

In this subsection, we discuss the choice of pre-determined parameters, our strategy to estimate bilateral trade costs $\tau(i, n)$ and further data needed to quantify our model.

Basic parameters. We choose baseline values for α, β, γ, η and σ by relating to available estimates from the empirical literature.

First, we set the agglomeration externality $\alpha = 0.05$ which falls in the range of 3-8 percent that Rosenthal and Strange (2004) have identified as estimates from the literature (see also Combes and Gobillon 2015). This value is also close to the estimate of 6 percent found in the seminal study by Ciccone and Hall (1996). For robustness checks, however, we consider values for α between 0 and 0.10, which seems to span the full reasonable range for the size of agglomeration externalities that the empirical literature has identified.

Second, our chosen basline value for the congestion externality β is derived from available evidence regarding the two micro-foundations discussed in Section 2.6: higher housing prices in larger cities, and individual location tastes. Regarding the former, Allen and Arkolakis (2014) show that their model is isomorphic to models where households spend a constant income share on housing, δ, such that $\beta_0 = \delta/(1-\delta)$. According to Eurostat, average expenditure on housing in Germany amounts to roughly 25 percent in 2010, which in turn leads to a value of $\beta_0 \approx 0.33$.[24] On the latter, recall that β contains idiosyncratic location tastes and the associated frictions. If those preferences are distributed Frechet with shape parameter $k = 3$, as suggested by Bryan and Morten (2019), the overall value of β can be written as $\beta = \beta_0 + 1/k$, which rationalizes our choice of $\beta = 0.33 + 1/3 = 0.66$ as the baseline value for the congestion elasticity. However, we will consider the full admissible range $\beta \in [0, 1]$ in the robustness checks.

Third, γ is the expenditure share on public goods given the assumed Cobb-Douglas utility function. With a balanced overall budget this is, in turn, equal to the average tax rate (before redistribution). Tax data for Germany thus suggest to set $\gamma = 0.2$ as our baseline. Fourth, we assume that local governments provide pure public goods, i.e. $\eta = 0$, but we also study the other extreme of a pure private transfer ($\eta = 1$) in the robustness checks. Finally, the elasticity of substitution σ plays a role for the estimation of trade costs. We follow Simonovska and Waugh (2014) in choosing a value of $\sigma = 5$.

Data and estimation of the trade elasticity. Finally, quantifying our model requires data on inter-regional bilateral distances and trade flows, as well as on population and labor income per local labor market. Data for population sizes and aggregate income

[24] We use information on the final consumption expenditure of households by consumption purpose (COICOP 3 digit) from Eurostat with the code: nama_10_co3_p3.

(GDP) for every region are readily available from the German Statistical Office (2011b).[25] We then compute the ratio of the two as a proxy for the regional wage level. Moreover, using GIS software, we obtain bilateral Euclidian distances between the centroids of local labor markets. This information is needed to estimate trade costs.

Regarding trade flows, we use information from the Forecast of Nationwide Transport Relations in Germany (Verkehrsverflechtungsprognose 2030) provided by the Clearing House of Transport Data at the Institute of Transport Research of the German Aerospace Center.[26] The data contain bilateral trade volumes in metric tons at the product level by transport mode (road, rail, water) between European regions, where one German region is either exporter, importer or part of the trade route in the year 2010.

Our theoretical model requires trade *values* rather than *volumes*, so we convert the data by using unit values by product group available from COMTRADE at the national level. We take both a simple average of unit values by product group (to arrive at the two-digit level) and a weighted average where values serve as weights. We finally aggregate trade flows across transport modes to obtain a measure on the level of districts.

We follow the standard gravity literature (e.g. Head and Mayer, 2014) and estimate (5) with importer and exporter fixed effects in order to take multilateral resistance terms into account. We proxy bilateral trade costs by the Euclidian distance $dist(i, n)$ between the centroids of locations i and n according to

$$\tau(i, n) = dist(i, n)^{\epsilon} \tilde{e}(i, n), \tag{15}$$

where $\tilde{e}(i, n)$ is the error term. Log-linearizing (5) and substituting the parametrization of trade costs according to (15) yields the following gravity equation for the value of bilateral trade flows from i to n:

$$\log X(i, n) = \zeta(i) + \kappa(n) - (\sigma - 1)\epsilon \log dist(i, n) + (1 - \sigma)b'\mathbf{M} + \log e(i, n), \tag{16}$$

where $\zeta(i)$ and $\kappa(n)$ are exporter and importer fixed effects that control for wages, productivity, population and the CES price index.[27] $\mathbf{M}$ collects standard bilateral control variables from the gravity literature,[28] and $\log e(i, n) = (1 - \sigma) \log \tilde{e}(i, n)$.

Table 2 summarizes the regression results.[29] Columns 3 to 4 refer to bilateral trade values, where unit values are applied to the volume data. Following Nitsch and Wolf (2013),

[25] Instead of population sizes, we have also considered density, i.e., population divided by area size in region i. The results are reported in Appendix A.5 and turn out to be similar to those reported below.

[26] The data can be accessed via http://daten.clearingstelle-verkehr.de/276/. It is similar to the US commodity flow survey. See Henkel and Seidel (2019) for further details about these data.

[27] We exploit variation across product groups by adding product fixed effects.

[28] Following Lameli, Nitsch, Suedekum, and Wolf (2015), we include a historical dialect similarity measure and dummy variables for adjacent regions and for regions located in different states.

[29] We use trade flows across 401 NUTS3-districts for this estimation to have higher statistical power, but an estimation of the trade elasticity across local labor markets yields very similar results.

we also explore results for trade volumes instead of values as the dependent variable in columns 1 and 2. Although this deviates from the theoretical model, those results provide important robustness checks, especially because dummy variables account for the product-specific price per ton that converts volume of exports into values.

Table 2: ESTIMATED DISTANCE ELASTICITIES

	volumes		values	
log(distance)	-1.26***	-0.98***	-1.23***	-0.93***
	(0.002)	(0.004)	(0.003)	(0.005)
dialect sim.		0.23***		0.24***
		(0.013)		(0.015)
contiguity		0.52***		0.58***
		(0.010)		(0.011)
state border		-0.46***		-0.46***
		(0.005)		(0.006)
Exporter FE	✓	✓	✓	✓
Importer FE	✓	✓	✓	✓
Product FE	✓	✓	✓	✓
Constant	3.10***	3.56***	17.5***	18.0***
	(0.066)	(0.065)	(0.079)	(0.078)
Observations	1,104,635	1,104,635	853,950	853,950
R^2	0.41	0.41	0.70	0.70

Notes: Columns 1 and 2 use the original volume data from VVP. Columns 3 and 4 are based on trade values where we have used the simple average of unit values per 2-digit product group. Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

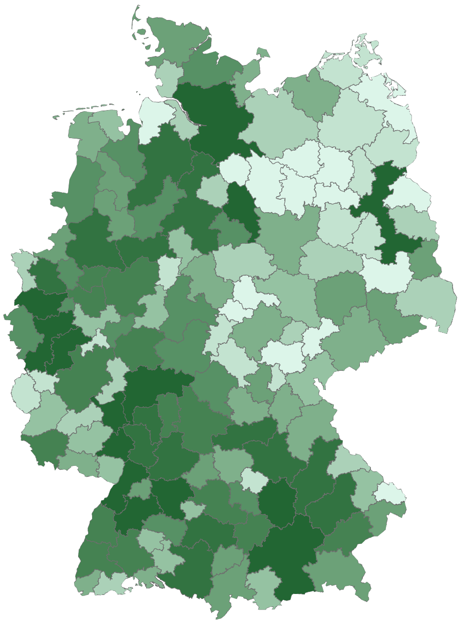
We find that the point estimates for the distance effects range between -0.93 and -1.26. They are highly statistically significant, and firmly in line with available estimates from the gravity literature. This remains true when adding controls for historical ties (as measured by dialect similarity), contiguity, and administrative borders in columns (2) and (4). Head and Mayer (2014) conclude that estimates of the trade-distance elasticity parameter ϵ in typical gravity equations cluster around -1.1, with a standard deviation of 0.41. Given our estimation results, we parameterize trade costs according to the formula $\tau(i,n)^{1-\sigma} = dist(i,n)^{-1.23}$ using bilateral distances.

4.5 Amenities and productivities

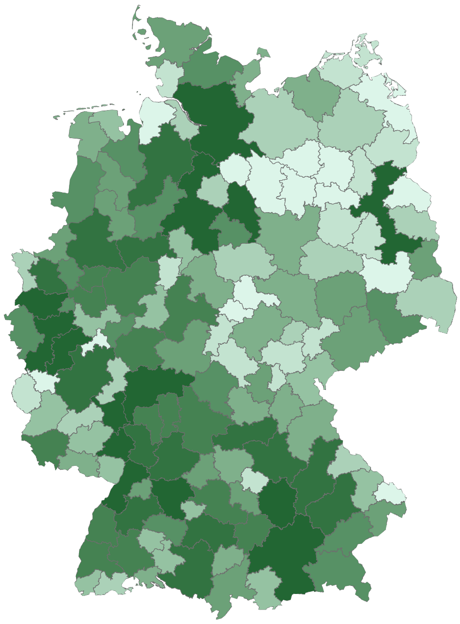
Given our parameter choices and estimates for trade costs, the last step is to back out exogenous productivities $\bar{A}(i)$ and amenities $\bar{u}(i)$ for every local labor market from our

Figure 5: Estimated exogenous productivities and amenities

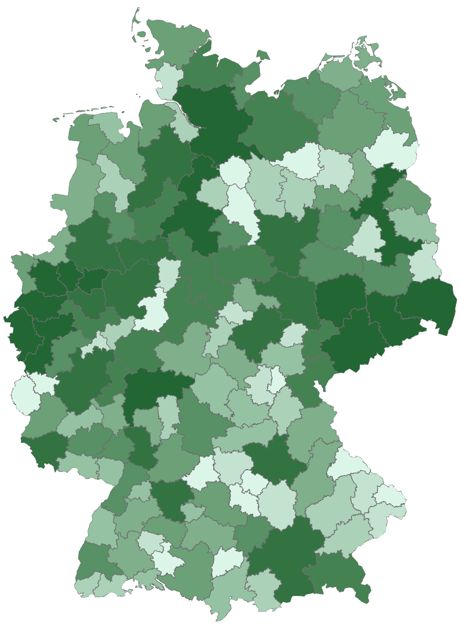
(a) Exogenous productivities



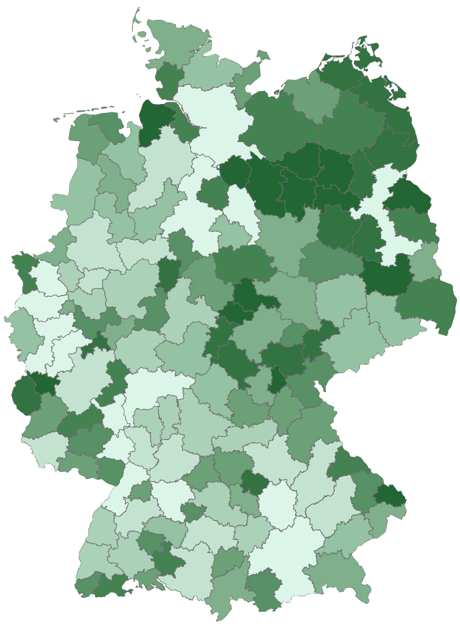
(b) Composite productivities



(c) Exogenous amenities



(d) Composite amenities



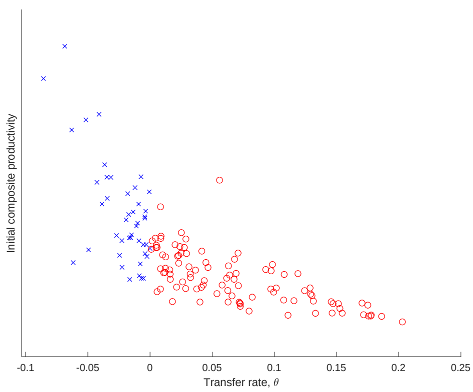
Notes: This figure plots the exogenous and composite productivities $\bar{A}(i)$ and $A(i)$, and the respective amenities $\bar{u}(i)$ and $u(i)$ for $\alpha = 0.05$, $\beta = 0.66$, $\gamma = 0.2$ and $\eta = 0$. A darker shading indicates higher values.

general equilibrium model. To do so, we plug in estimated trade costs $\tau(i,n)$ together with information on population $L(i)$, wages $w(i)$, tax rates $t(i)$, and transfer rates $\theta(i)$ into (13) and (14). This defines a system of 2×141 equations in 2×141 unknowns, and labor-market clearing pins down the equalized welfare level W in this system.

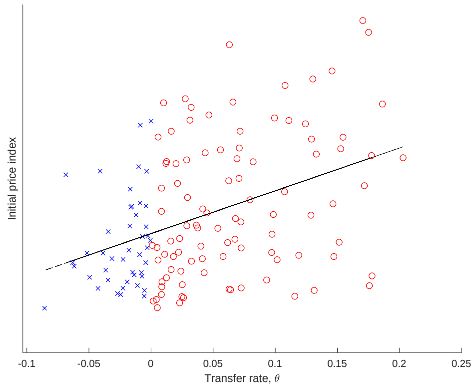
The map in panel (a) of Figure 5 shows the pattern of exogenous productivities $\bar{A}(i)$. It tends to be low in the East and high in the South-West of Germany especially in the local labor markets around the big cities. Combining this information with location-specific population delivers composite productivity $A(i) = \bar{A}(i)L(i)^{\alpha}$, which is shown in panel (b) and exhibits a similar spatial pattern. This productivity is positively correlated with regional per-capita income, and therefore negatively with the net receipts of fiscal transfers in Germany. This is also shown in panel (a) in Figure 6, where we document the relationship between $A(i)$ and the local transfer rate $\theta(i)$.

Figure 6: LOCAL PRODUCTIVITY, PRICE INDICES AND THE TRANSFER RATE

(a) Composite productivity, $A(i)$



(b) Price index, $P(i)$



Notes: Panel (a) shows the level of the estimated composite productivity $A(i)$ in relation to $\theta(i)$. Panel (b) depicts the level of the price index in relation with the transfer rate.

Panels (c) and (d) in Figure 5 show the patterns of exogenous and composite amenities $\bar{u}(i)$ and $u(i)$, respectively. Composite amenities deviate from exogenous amenities due to differences in population levels. This leads to relatively low levels of $u(i)$ in the more densely populated South-West of Germany. Finally, we observe from panel (b) of Figure 6 that recipients are characterized by a higher price index, which can be interpreted as a measure of remoteness. In Appendix A.4 we find a similar pattern when using the remoteness indicator by Baldwin and Harrigan (2011). This suggests that the German transfer schemes indeed tends to shift resources from the center towards remote locations.

The amenities and productivities shown in Figure 5 are an essential part of the spatial equilibrium in our model, although they are hard to compare with observable regional characteristics or measures of well-being. The concept of spatial equilibrium is a key feature of recent quantitative economic geography frameworks, but it is not undisputed.[30] For the particular case of Germany in 2010, however, this assumption does not seem to be too unrealistic. First, "equivalent living conditions" everywhere in the country are specifically part of the German constitution. Second, *actual* net migration across districts amounted to only around 100,000 people per year in the decade 2000–2010 (German Statistical Office, 2011b), i.e., less than 0.1 per cent of the population. Moreover, those small flows had no systematic geographical pattern anymore. The huge migration wave from East to West, which occurred after re-unification, had come to a halt since the late 1990s and was entirely stopped by 2010, the year of our analysis. Those facts are consistent with the tenet of spatial equilibrium in our initial constellation.

5 Counterfactual analysis: Abolishing fiscal transfers

To assess the various economic effects of fiscal transfers, we now perform a counterfactual analysis. We start from the initial spatial equilibrium described in the previous Section, which is influenced by the actual fiscal transfers that were observed in Germany in 2010. Then we simulate a scenario, where the entire fiscal transfer scheme is abandoned. This counterfactual corresponds to a situation where all local public goods must be financed by taxes levied upon local economic activity, but without any cross-regional fiscal transfers.[31] By comparing this counterfactual to the initial observed equilibrium, we analyze the impact of fiscal transfers on the location choices of individuals within Germany, the implied regional migration flows, the aggregate level and the distribution of productivity and output across regions, as well as on national welfare.

5.1 Setup of the counterfactual analysis

In the baseline version of our counterfactual analysis, we assume fixed values of the exogenous parameters and the same local tax rates $t(i)$ and trade costs $\tau(i,n)$ as in the initial equilibrium. We also assume that the exogenous productivities $\bar{A}(i)$ and amenities $\bar{u}(i)$ remain unchanged. We then impose zero fiscal transfers for all regions, $\theta(i) = 0 \ \forall i \in N$, and use our model (13) and (14) to solve for the new (counterfactual) equilibrium values of wages $w(i)$ and population $L(i)$ that are consistent with equalized utility across space.

Using those equilibrium values allows us, in turn, to compute the composite productivities and amenities, as well as all other endogenous variables (such as public goods, spending, and GDP) for all regions. Finally, it yields output and productivity at the national level, and the *change* in aggregate welfare from the old to the new equilibrium.

[30] For a recent discussion, see Ahlfeldt, Bald, Roth and Seidel (2019), Heise and Porzio (2018), and Gollin, Kirchberger and Lagakos (2017).

[31] Alternatively, the counterfactual scenario may be thought of as one with balanced trade for all regions.

This latter piece of information, denoted $\hat{W}$, then entails the overall welfare implication of the fiscal transfer scheme.

5.2 Location decisions and migration

We start the discussion of our results with the implied re-location decisions. The examples in Section 3 have clarified that the introduction of a fiscal transfers creates incentives for individuals to move towards the recipient regions, because the transfers allow for more public goods provision and thus make those regions relatively more attractive. Analogously, the abandoning of fiscal transfers should therefore induce people to leave the former recipient and move towards the former donor regions.

Figure 7 shows that our quantitative multi-region model exhibits exactly this pattern. The map depicts changes in local population sizes after switching off transfers. People leave East Germany and less densely populated areas in the West and move towards the big cities (e.g., Frankfurt, Munich, Düsseldorf) as well as towards the Southern part of the country. Some former recipients in East Germany lose up to 20 percent of their population in the long run, while some donors receive an inflow of up to 18 percent.

The relationship between the prevailing transfer rate $\theta(i)$ in the initial equilibrium, and the implied change in local population size after setting all transfer rates equal to zero, is shown in panel (b) of Figure 7. Former donors (indicated by blue crosses with $\theta(i) < 0$) indeed gain, while former recipients (the red circles with $\theta(i) > 0$) lose population.

At the aggregate level, abandoning fiscal transfers would induce 2.7 million individuals (3.3 percent of the population) to change their local labor market, but one should bear in mind that our counterfactual analysis refers to a long-run spatial equilibrium. The adjustment would probably not be instantaneous as in our model, but take a substantial amount of time in reality.

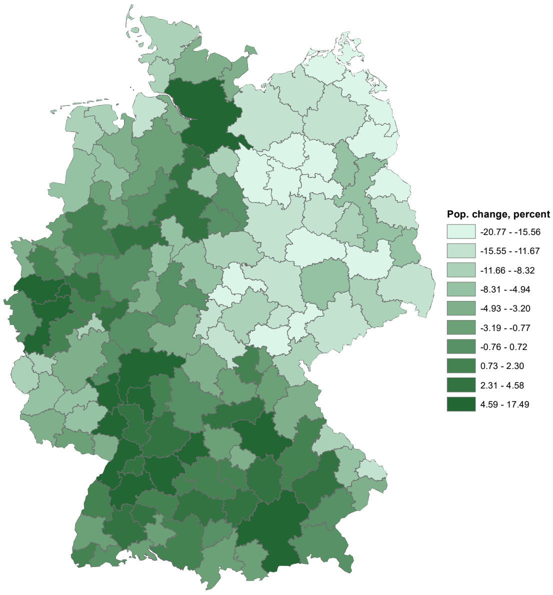
5.3 Local public goods provision

The abandoning of fiscal transfers directly affects government budgets and therefore local public goods provision across local labor markets. It is decreasing in the former recipient regions which lose funding, and increasing in the former donor regions which now keep all of their tax revenues. In addition, there are two indirect effects because individuals are mobile across regions and wage levels are endogenous.

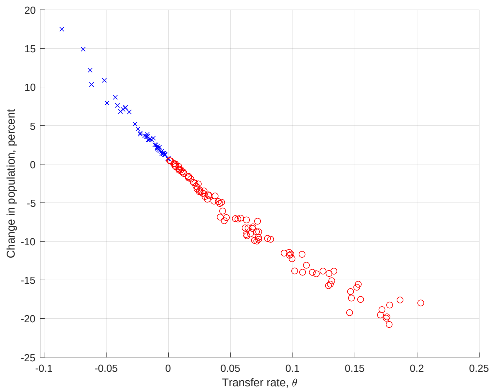
The implied migration responses mean that the tax bases erode (enlarge) in former recipient (donor) regions, which face outward (inward) migration. However, panel (a) of Figure 8 shows that local wage levels move into the opposite direction. Wages are increasing in the former recipient areas, because emigration reduces labor supply and thus

Figure 7: Changes in local population

(a) Geographical pattern



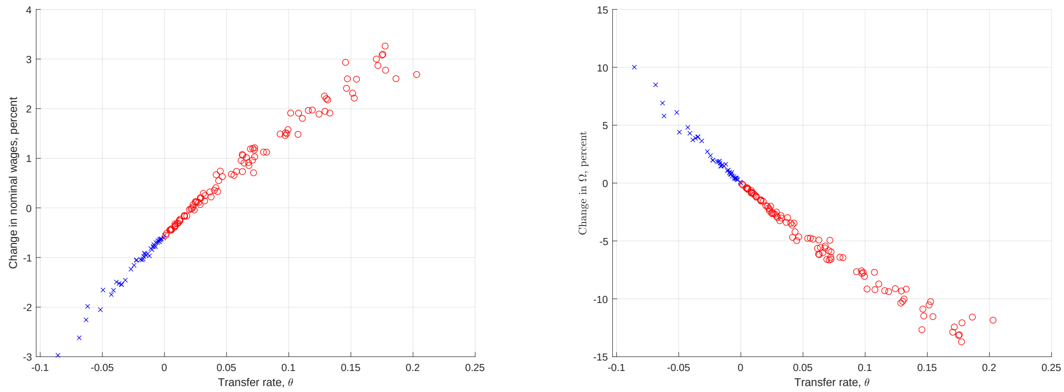
(b) Transfer rate and population change



Notes: Panel (a) shows pattern of population changes from the initial to the counterfactual equilibrium. Panel (b) relates population changes to the level of the initial transfer rate $\theta(i)$.

Figure 8: Changes in wages and local public services

(a) Wages (b) Local public services



Notes: Panel (a) plots change in the local nominal wage against the initial transfer rate θ. Panel (b) shows changes in local public goods provision (adjusted for the local price level) and the initial transfer rate.

location-specific intermediate inputs. The former donor regions become more populous, in turn, and goods market clearing implies falling prices for their local intermediates.

Summing up all three effects, we observe in panel (b) that former recipients (donors) of fiscal transfers end up with a decreasing (increasing) level of local public goods provision. For local tax bases, we conclude that the sum of the direct and the indirect migration effect seems to outweigh the indirect wage effect. Abandoning fiscal transfers therefore leads to a divergence in the quality of local public goods across regions.

5.4 Output and productivity

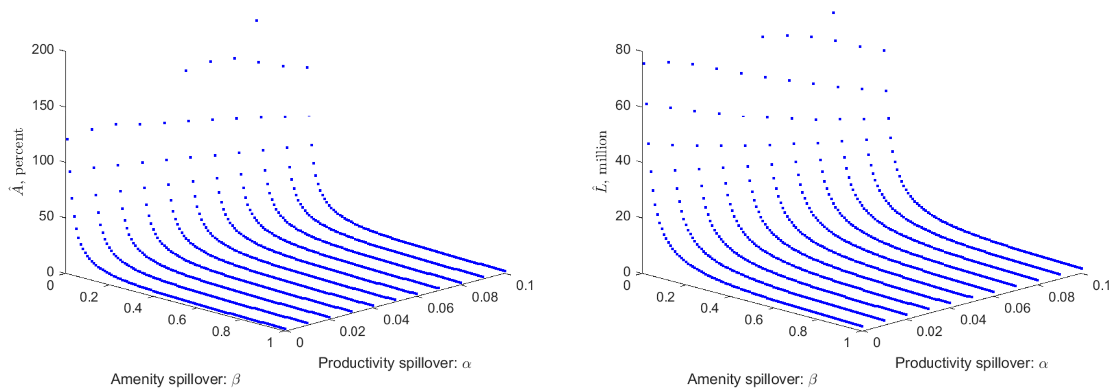
The induced migration responses trigger further changes in composite productivities across regions. In particular, the former donor regions which receive inward migration experience a boost via endogenous agglomeration economies. The opposite happens in the former recipient regions which experience outward migration, hence falling productivity. Bearing in mind that the donors already had an edge in the initial equilibrium (see Figure 5) we thus find that regional productivity differences are amplified in the counterfactual.

Since individuals move from less productive towards more productive areas when transfers are abandoned, we observe an increase in average productivity at the national level. In the baseline version of our counterfactual analysis this gain is equal to 3.4 percent, and real GDP per capita grows by 1.8 percent on average. Put differently, with respect to output and productivity, we find that fiscal transfers limit their dispersion across regions, but this comes at the cost of lower aggregate productivity at the national level.

Robustness. Notice that our empirically motivated baseline quantification ($\alpha = 0.05$, $\beta = 0.66$, $\gamma = 0.2$ and $\eta = 0$) satisfy condition 1 stated above, which ensures existence and uniqueness of equilibrium ($0.66 = \beta > \alpha + \gamma(1-\eta) = 0.25$). In Figure 9, we now explore the counterfactual results for different parameter settings where this condition may no longer hold. In particular, we depict the change in national average productivity (denoted $\hat{A}$) and the corresponding volume of migration (denoted $\hat{L}$) for various constellations of α and β which are the two key parameters in our analysis.[32] We allow α to vary between 0 and 0.1, which seems to span the empirically relevant range for the size of agglomeration externalities that the recent empirical literature (e.g. Rosenthal and Strange 2004; Combes and Gobillon 2015) has identified. For the congestion externality, we remain agnostic and depict the full admissible parameter space for β between 0 and 1.[33]

Figure 9: CHANGES IN AGGREGATE PRODUCTIVITY

(a) National productivity change (b) Total migration

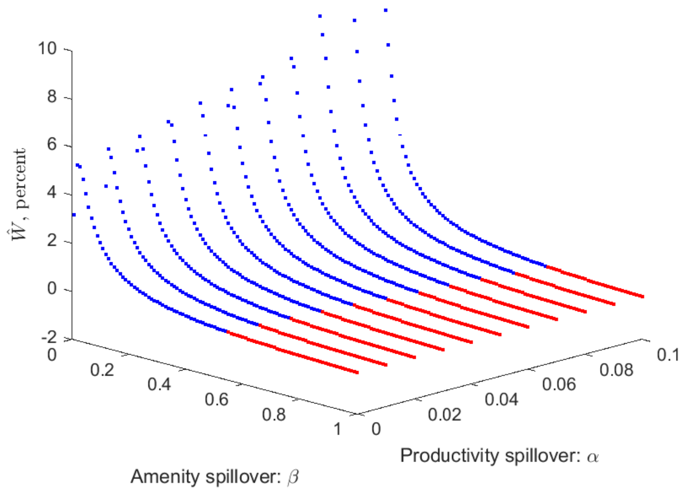


It is evident from panel (a) of Figure 9 that national productivity increases in *all* cases. The gain tends to be stronger the smaller is β, and the larger is α. Smaller levels of β imply weaker congestion forces and, thus, larger migration flows as can be seen also in panel (b). Those migration flows from less to more productive regions, in turn, translate into higher aggregate productivity gains, and this channel becomes even stronger the higher is the agglomeration elasticity α.

[32]Robustness checks for γ and η are in sub-section 5.6 below. Further unreported checks suggest that the two additional parameters $\sigma = 5$ and $\epsilon = -1.23$ have only minor impacts on the counterfactual results.

[33]The assumption $\gamma(1-\eta) = 0.2$ is maintained throughout. Condition 1 therefore holds when $\beta - \alpha > 0.2$, and no longer holds otherwise. We are still able to numerically solve for an equilibrium for the parameter range depicted in Figure 9. Outside that range, we often do not find an equilibrium.

Figure 10: Aggregate welfare effects of fiscal transfers



Notes: Percentage change in equalized indirect utility across regions after abandoning fiscal transfers. Blue indicates positive, and red negative values.

5.5 Welfare implications of fiscal transfers

The migration responses triggered by the removal of fiscal transfers do not only affect productivity and output, but also the endogenous congestion forces. In particular, composite amenities decrease in former donor regions, which receive inward migration and become even more crowded than they already were in the initial equilibrium. The former recipient regions, by contrast, lose population. This relaxes local congestion, and raises amenities in those areas. Those implied changes in local amenities are key for the aggregate welfare implications of fiscal transfers. It is clear that indirect utility is equalized across all regions in the old and in the new equilibrium, but the question is at what level.

In our baseline case of the counterfactual analysis, this common welfare drops by 0.06 percent after abandoning the fiscal transfer scheme, i.e., $\hat{W} = -0.06$. Stated differently, even though the removal of fiscal transfers always leads to a notable output and productivity gain at the national level, it leads to lower national welfare in this case. What is the intuition of this result?

Recall that our model can exhibit a negative net agglomeration externality, i.e., dispersion forces which are stronger than agglomeration forces at the margin. Endogenous amenities decline substantially in locations that experience inward migration, and this decline is stronger than the productivity gains arising from endogenous agglomeration forces and the benefits from sharing public facilities. In other words, the former donor regions become more productive, but also much more congested, and the latter effect seems to dominate the overall welfare evaluation in our baseline scenario.

Robustness. Figure 10 plots welfare changes $\hat{W}$ for the same parameter constellations of α and β as in Figure 9 above. We observe that, depending on parameters, the change in overall welfare can be positive (depicted in blue) or negative (depicted in red), but in all cases it tends to be an order of magnitude smaller (in absolute terms) than the implied change in aggregate productivity.

More specifically, abandoning fiscal transfers leads to a stronger welfare loss if β is large and α is small. Thus, by analogy, this means that the introduction of fiscal transfers implies a stronger welfare gain in those cases. The reason is that net agglomeration externality is then more strongly negative, which implies a higher degree of over-congestion. The fiscal scheme therefore tackles a larger problem in those parameter constellations.

We can also relate the findings from Figure 10 to the insights of the stylized examples that we discussed in Section 3. There we have shown that the introduction of fiscal transfers may decrease national welfare if it provides an incentive for individuals to move to remote locations, thereby exacerbating transport losses. However, introducing fiscal transfers may also increase welfare, because they work against the inherent tendency that productive cities tend to be "too large" from a social point of view. In our quantified multi-region model, where we consider the *abolition* of transfers as our counterfactual exercise, we are likely to face all of those channels in parallel. The actual fiscal transfer scheme in Germany tends to shift resources towards regions that are both remote and small. A priori, it is therefore not clear if removing transfers increases or decreases welfare. The quantitative pattern in Figure 10 echoes this general point.

5.6 Preferences for public services and their rivalry

We finally explore the sensitivity of our results with regard to the importance of public services in individuals' preferences, γ, and the degree of rivalry in consumption, η. So far we have kept $\gamma = 0.2$ in all simulations, and we have assumed pure (fully non-rival) local public goods by setting $\eta = 0$.

In Table 3 we report the counterfactual responses of welfare, productivity and migration for different parameter settings. Reducing γ from 0.2 to 0.15 reduces agglomeration forces, ceteris paribus, so the over-congestion without transfers becomes stronger relative to the baseline in welfare terms. As we observe from the first row in Table 3, abolishing fiscal transfers leads to a more pronounced welfare loss of -0.11 percent. The migration response is weaker with higher net congestion forces, however, and so is the increase in productivity. A similar reasoning applies when we turn public services into private transfers by setting $\eta = 1$. The agglomeration force from sharing a pure public good vanishes altogether, causing a stronger welfare effect of -0.19 percent when transfers are abandoned. Again, a lower migration response leads to a smaller productivity gain in the counterfactual.

Table 3: Importance and rivalry of public services

η	γ	$\hat{W}$ *in percent*	$\hat{A}$ *in percent*	$\hat{L}$ *in millions*	$\hat{L}$ *in percent*
0	0.15	-0.11	2.33	1.88	2.30
0	0.2	-0.06	3.37	2.70	3.30
1	0.2	-0.19	2.53	2.04	2.50

Notes: This table reports changes in welfare, average real wages, average labor productivity and migration (in millions and in percent of the total population) for $\sigma = 5$, $\alpha = 0.05$, $\beta = 0.66$ and different parameter values of η when income redistribution between locations is abolished.

6 Endogenous tax responses and optimal transfers

In this final section of the paper, we consider two extensions. First, we allow regions to endogenously adjust their local tax rates after the fiscal transfers have been abandoned. Second, we discuss the design of an optimal transfer scheme in Germany.

6.1 Endogenous tax responses

After transfers have been turned off in the counterfactual, all regions become "fiscally autonomous", meaning that each region now has to finance its local public goods purely from taxes on local economic activity. So far we have assumed, however, that all regions maintain their previous tax rates $t(i)$ from the initial equilibrium. On the one hand, this reflects the reality that local governments in Germany have little discretion in setting tax rates. On the other hand, it is natural to explore how regions would adjust their tax rates in their new state of "fiscal autonomy", if they had the opportunity to do so.

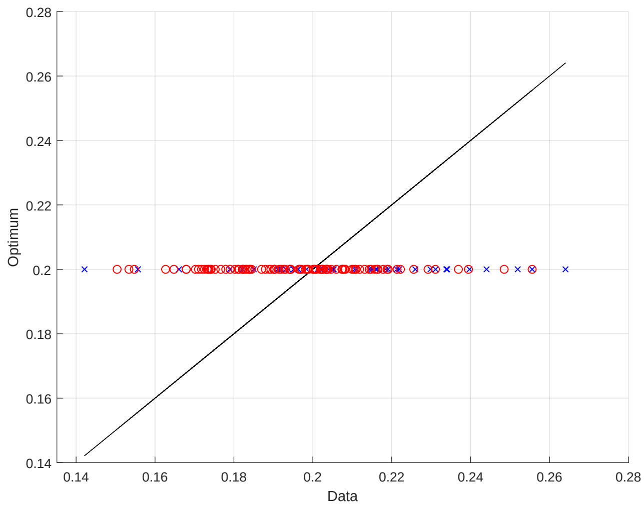
To analyze this scenario, we introduce a social planner who sets local tax rates $t(i)$ in a decentralized economy to maximize the sum of welfare over all locations. The social planner's problem can be stated as:

$$\max_{t(i)} \int_N L(i)W(i)di, \tag{17}$$

subject to the constraints imposed by the equilibrium conditions from section 2.7. We proceed as follows: we assume the same set of baseline parameters as in the previous analysis, set fiscal transfers to zero ($\theta(i) = 0$), and then solve the system of equations for wages $w(i)$ and populations $L(i)$ for different constellations of the local tax rates. We iteratively repeat this procedure for different values of $t(i)$ to numerically solve for the optimal tax rates that yield the highest level of national welfare.

This solution is illustrated in Figure 11 and turns out to be quite simple. Given that $\gamma = 0.2$ holds, local tax rates endogenously adjust to $t(i) = 0.2 \;\; \forall i \in N$. In other words, in a world without fiscal transfers, the optimal tax rates are the same in all regions and equal to the weight of public goods in the Cobb-Douglas utility function. This tax regime can be thought of as the coordinated equilibrium when strategic tax competition between the single jurisdictions is ruled out. The solution $t(i) = \gamma$ is then equivalent to the tax that a local government would choose in a state of autarky when maximizing local welfare.[34]

Figure 11: Optimal against observed tax rates



Notes: We simulate a counterfactual scenario without fiscal transfers for all regions, $\theta(i) = 0 \; \forall i \in N$, and solve for the new (counterfactual) equilibrium values of wages $w(i)$, population $L(i)$, and local tax rates $t(i)$ that are consistent with equalized utility across space. This figure shows the optimal local tax rates relative to the data.

Comparing national welfare between the initial and the counterfactual equilibrium, we now observe a welfare gain of 0.06. That is, $\hat{W} = 0.06$ if fiscal transfers are cut off *and* local tax rates can adjust endogenously. By contrast, recall that without local tax responses we have found $\hat{W} = -0.06$ in the previous section. In other words, the possibility to adjust local tax rates now implies a welfare gain at the national level when fiscal equalization is abolished, and this endogenous tax response effectively leads to a harmonization of local tax rates in the social optimum. The latter result is in line with Fajgelbaum, Morales, Suárez Serrato and Zidar (2019), who also show that harmonizing local tax rates across states in the U.S. economy increases aggregate welfare.

The other implied economic changes between the initial and the counterfactual equilibrium are roughly similar, regardless of whether local tax rates adjust or not. More specifically, productivity gains (3.3 percent) and real GDP growth (1.8 percent) at the national level are similar to the case where fiscal transfers are abolished without adjusting

[34]Exploiting strategic tax competition among the 141 German regions is beyond the scope of this paper.

local tax rates. The response in migration is also equally large, and goes along with a similar geographical pattern of population changes as in the previous section.

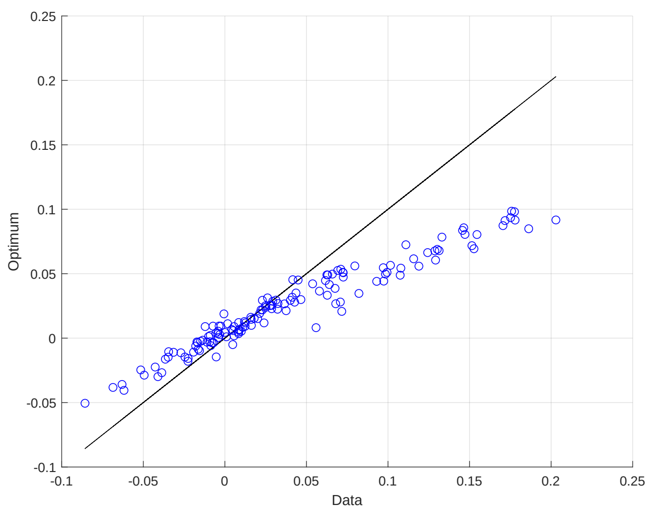
6.2 Optimal transfers

Finally, we explore the *optimal* transfer scheme in this economy similarly as in Fajgelbaum and Gaubert (2018) or in Blouri and Ehrlich (2017). Specifically, we now introduce a social planner who is able to set all local transfer rates $\theta(i)$ in order to maximize national welfare.

This problem is similar as in (17), except that the planner takes local taxes $t(i)$ as given (as initially observed in the data) and now has a different instrument at her disposal. By setting transfers, she indirectly governs the population distribution, because all prices and individual location decisions adjust endogenously in the decentralized market equilibrium.

The problem is solved numerically by assuming the same set of baseline parameters and tax rates $t(i)$ as in the previous analysis, and then solving the system of equations for wages $w(i)$ and populations $L(i)$ for different constellations of the local transfer rates. We iteratively search over the domain of $\theta(i)$ for the constellation that yield the highest national welfare. Figure 12 illustrates this optimal transfer scheme.

Figure 12: Optimal against observed transfer rates



Notes: Given the observed local tax rates $t(i)$ we simulate a counterfactual scenario, where we compute optimal transfer rates $\theta(i)\ \forall i \in N$, and solve for the corresponding equilibrium values of wages $w(i)$, and population $L(i)$, that maximize equalized utility across space. This figure shows the optimal transfer rates relative to the data.

We plot the optimal against the observed transfer rate from the initial equilibrium for all 141 German regions. The currently operated system of fiscal equalization would be socially optimal if all dots were located on the 45-degree-line. However, as can be seen in Figure 12, this is not the case. The optimal regime rather implies less equalization than what we currently observe. More specifically, optimal transfers are higher than their observed counterparts for initial donors, and lower for initial recipients.

Implementing this scheme, i.e., cutting the observed transfers to the optimal level, implies a welfare gain of 0.20 percent in the baseline constellation. That is, $\hat{W} = 0.20$ rather than the $\hat{W} = -0.06$ which we have found for the counterfactual where all transfers were abolished completely. The geographical pattern of population changes is similar as in Figure 7, but fewer people move since transfers are just reduced but not abolished completely (only 1.3 million instead of 2.7 million). Average productivity increases by 1.4 percent and real GDP by 0.9 percent, which is also less than in the extremer counterfactual.

Summing up, some degree of fiscal equalization is optimal. This follows from the trade-offs that we have discussed in Section 3: transfers might induce workers to locate in remote and unproductive locations, but at the same time they mitigate over-congestion in large cities. The optimal transfer scheme balances those forces. Yet, the current fiscal equalization scheme in Germany seems to provide somewhat "too much" redistribution.

7 Conclusions

Fiscal transfers between jurisdictions shape the spatial economy. We use a general equilibrium model with trade and labor to carve out aggregate effects of fiscal transfers on welfare, productivity and labor . Welfare effects of fiscal transfers are ambiguous from a purely theoretical point of view. Externalities cause inefficiently large cities in our model, so that transfers from rich to poor places partly mitigate this mis-allocation of labor. However, costly trade implies that transfers reduce welfare if recipients are located in the remote periphery and, thus, have a higher price index.

In our quantitative exercise we calibrate the model for Germany. Abolishing fiscal transfers completely leads to regional migration from poor (low-productive) to rich (high-productive) locations raising average labor productivity and output. However, negative congestion externalities tend to be stronger at the margin, and the abolition of transfers may even cause a welfare loss. Stated differently, fiscal transfers across jurisdictions may be costly in terms of output and productivity, but still they can make the residents of the country better off in total.

Our analysis also suggests that the current system of fiscal equalization in Germany is not socially optimal. Transfers should be reduced to enhance efficiency at the national level, but they should not be cut to zero. As an aside, this exercise also highlights that national productivity or real GDP are the wrong statistics to look at when it comes to exploring the efficiency of fiscal transfers: starting from the current system, completely abolishing all transfers implies larger productivity and GDP gains than a mere reduction of current transfers to their optimal levels, but not higher welfare.

References

Ahlfeldt, G., F. Bald, D. Roth and T. Seidel 2019. The spatial equilibrium with migration costs. *unpublished manuscript,* London School of Economics.

Albouy, D. 2012. Evaluating the efficiency and equity of federal fiscal equalization. *Journal of Public Economics* **117(4)**, 635-667.

Albouy, D., K. Behrens, F. Robert-Nicoud, and N. Seegert. 2019. The optimal distribution of population across cities. *Journal of Urban Economics* **110**, 102-113.

Allen, T. and C. Arkolakis. 2014. Trade and the topography of the spatial economy. *Quarterly Journal of Economics* **129(3)**, 1085-1139.

Austin, B., E. Glaeser and L. Summers. 2018. Jobs for the Heartland: Place-Based Policies in 21st-Century America. *Brookings Papers on Economic Activity* **2018(1)**, 151-255.

Baldwin, R., and J. Harrigan. 2011. Zeros, quality, and space: Trade theory and trade evidence. *American Economic Journal: Microeconomics* **3(2)**, 60-88.

Becker, S., P. Egger M. von Ehrlich. 2010. Going NUTS: The effect of EU Structural Funds on regional performance. *Journal of Public Economics* **94**, 578-590.

Blouri, Y., M.v. Ehrlich. 2017. On the optimal design of place-based policies: A structural evaluation of EU regional transfers. *CESifo Working Paper 6742.*

Blöchliger, H., O. Merk, C. Charbit and L. Mizell. 2007. Fiscal equalisation in OECD countries, OECD Working Papers on Fiscal Federalism, No. 4, OECD Publishing, Paris.

Bryan, G. and M. Morten. 2019. The Aggregate Productivity Effects of Internal Migration: Evidence from Indonesia. *Journal of Political Economy*, forthcoming.

Busso, M., J. Gregory, and P. Kline. 2013. Assessing the Incidence and Efficiency of a Prominent Place-based Policy. *American Economic Review* **103(2)**, 897-947.

Ciccone, A. and R.E. Hall. 1996. Productivity and the density of economic activity. *American Economic Review*, **86(1)**, 54-70.

Combes, P., G. Duranton, and L. Gobillon. 2019. The Costs of Agglomeration: House and Land Prices in French Cities. *Review of Economic Studies*, **86(4)**, 1556-1589.

Combes P. and L. Gobillon. 2015. The Empirics of Agglomeration Economies, in G. Duranton, J.V. Henderson, and W.C. Strange, eds., Handbook of Regional and Urban Economics, Vol. 5, Elsevier, 247-348.

Dekle, R., J. Eaton and S. Kortum. 2007. Unbalanced trade. *American Economic Review* **97(2)**, 351-355.

Ehrlich, M. von and T. Seidel. 2018. The persistence effects of place-based policies. Evidence from the West-German Zonenrandgebiet. *American Economic Journal: Economic Policy* **10(4)**, 344-74.

Fajgelbaum, P.D. and C. Gaubert. 2018. Optimal spatial policies, geography and sorting. University of California, Berkeley. Unpublished manuscript.

Fajgelbaum, P.D., E. Morales, J.C. Suárez Serrato and O. Zidar. 2019. State taxes and spatial misallocation. *The Review of Economic Studies* **86(1)**, 333-37.

Federal Ministry of Finance. 2015. Bund-Länder-Finanzbeziehungen auf der Grundlage der Finanzverfassung, Berlin.

Federal Ministry of Finance. 2016. The federal fiscal equalisation system in Germany, Berlin.

Flatters, F., J. V. Henderson, P. Mieszkowski 1974. Public goods, efficiency, and regional fiscal equalization. *Journal of Public Economics* **3(2)**, 99-112.

German Statistical Office. 2011a. Fachserie 14, Finanzen und Steuern. Wiesbaden.

German Statistical Office. 2011b. Fachserie 1, Bevölkerung und Erwerbstätigkeit. Wiesbaden.

Glaeser, E. and J. Gottlieb. 2008. The economics of place-making policies. *Brookings Papers on Economic Activity* Spring: 155-253.

Gollin, D., M. Kirchberger and D. Lagakos. 2017. In Search of a Spatial Equilibrium in the Developing World. *NBER Working Paper 23916*

Head, K. and T. Mayer. 2014. Gravity equations: Workhorse, toolkit, and cookbook. *Handbook of International Economics*, Elsevier. Gita Gopinath, E. H. and Rogoff, K. (Eds.), **Vol. 4**, 131-195.

Heise, S. and T. Porzio. 2018. Why Do Spatial Wage Gaps Persist? Evidence from the Enduring Divide between East and West Germany. Working Paper

Helpman, E. 1998. The size of regions. In: Topics in Public Economics: Theoretical and Applied Analysis, (ed.) D. Pines, E. Sadka and I. Zilcha, 33-54. Cambridge: Cambridge University Press.

Henderson, J. V. 1974. The sizes and types of cities. *American Economic Review* **64(4)**, 640-656.

Henkel, M. and T. Seidel 2019. A Spatial Perspective on European Integration: Heterogeneous Welfare and Migration Effects from the Single Market and the Brexit. *Econ Inq*, **57**: 333-352.

Henkel, M., T. Seidel and J. Suedekum 2018. Fiscal transfers in the spatial economy. *CEPR Discussion Paper 12875.*

Hsieh, C.-T. and E. Moretti. 2019. Housing constraints and spatial misallocation. *American Economic Journal: Macroeconomics* **11(2)**, 1-39.

Kline, P. and E. Moretti. 2014. Local economic development, agglomeration economies and the big push: 100 years of evidence from the Tennessee Valley Authority. *Quarterly Journal of Economics* **129(1)**, 275-331.

Lameli, A., V. Nitsch, J. Suedekum, and N. Wolf. 2015. Same same but different: Dialects and trade, *German Economic Review* **16(3)**, 290-306.

Neumark, D. and H. Simpson. 2015. Place-based policies, in G. Duranton, J.V. Henderson, and W.C. Strange, eds., Handbook of Regional and Urban Economics, Vol. 5, Elsevier, 1197-1288.

Nitsch, V. and Wolf, N. 2013. Tear down this wall: on the persistence of borders in trade, *Canadian Journal of Economics* **46(1)**, 154-179.

Polyanin, A. and Manzhirov, A. 2008. Handbook of Integral equations. London: Chapman and Hall/CRC.

Redding, S. J. 2016. Goods trade, factor and welfare. *Journal of International Economics* **101**, 148-167.

Rodríguez-Pose, A. 2018. The revenge of the places that don't matter (and what to do about it), *Cambridge Journal of Regions*, Economy and Society **11(1)**, 189-209.

Rosenthal, S. S. and Strange, W. C. 2004. Evidence on the nature and sources of agglomeration economies. *Cities and Geography*, Elsevier. Henderson, J. V. and J.-F. Thisse (Eds.), **Vol. 4**, 2119-2171.

Simonovska, I. and Waugh, M. E. 2014. The elasticity of trade: Estimates and evidence. *Journal of International Economics* **92(1)**, 34-50.

Zabreyko, P., A. Koshelev, M. Krasnosel'skii, S. Mikhlin, L. Rakovshchik, and V. Stetsenko 1975. Integral equations: A reference text. Leyden: Noordhoff International Publishing.

A Appendix

A.1 Solving the system of non-linear equations

We employ a method of successive approximations to solve for the equilibrium of the system of non-linear equations (see Zabreyko et al., 1975). In the following, we briefly describe the steps of the iterative procedure. First, we choose an arbitrary vector of non-negative starting values for the endogenous variables in equations (13)-(14). Next, we simultaneously solve the system of equations (13)-(14) for a given parametrization of trade costs and parameter values to obtain new vectors of solutions for the endogenous variables. To ensure convergence, we normalize each new vector to sum up to one. We then update the starting values according to a weighted average of previous starting values and solutions of the previous iteration. Finally, we iteratively solve the system of equations until the metric distance between the starting values and solutions of the endogenous variables becomes sufficiently small.

Existence and uniqueness theorems for non-linear equations are described by Polyanin and Manzhirov (2008). Under the condition that the sequence of convergence is an element of a complete metric space it will also converge to a limit point. Hence, the system of non-linear equations has at least one continuous solution.

A.2 Federal fiscal equalization scheme

Table A1 shows the volume of redistribution at each stage of the process. In sum, this amounts to 26.5 billion Euro or 5 percent of tax revenues. On a per-capita basis, Berlin leads the lists of recipients with 1,611 Euro per citizen and year. Hesse and Bavaria pay most in net terms with more than 400 Euro per year.

Table A1: Volume of redistribution, 2010

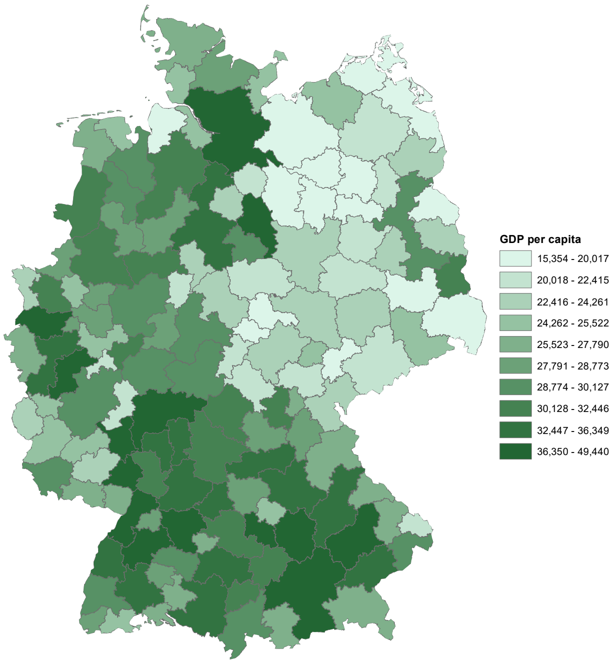
	VAT redistribution (million Euro)	Horizontal equalization (million Euro)	General grants (million Euro)	Special grants (million Euro)	Per capita transfers (Euro)
Bavaria	-1,545	-3,511	0	0	-403
Baden-Württemberg	-1,327	-1,709	0	0	-282
Berlin	58	2,900	912	1,706	1,611
Brandenburg	864	401	176	1,498	1,174
Bremen	-46	445	146	60	916
Hamburg	-220	-66	0	0	-160
Hesse	-749	-1,752	0	0	-412
Lower Saxony	378	259	127	0	96
Mecklenburg Western Pomerania	830	399	157	1,110	1,520
North Rhine-Westphalia	-2,204	354	119	0	-97
Rhineland Palatinate	-393	267	144	46	16
Saarland	125	89	46	63	317
Saxony	2,024	854	350	2,625	1,411
Saxony-Anhalt	1,201	497	202	1,616	1,506
Schleswig Holstein	-136	101	51	53	24
Thuringia	1,139	472	192	1,483	1,470
Sum	6,620	7,039	2,624	10,260	

Source: Federal Ministry of Finance (2015).

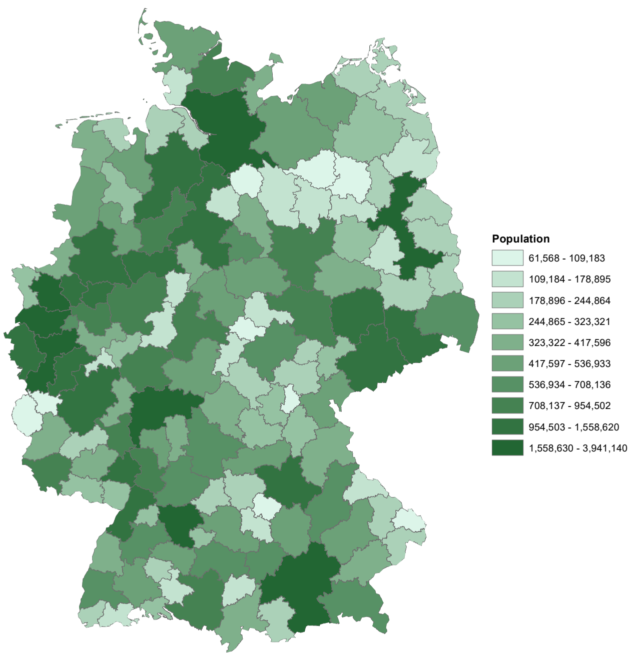
A.3 GDP per capita and population density

Figure A1: Distribution of GDP per capita and population density in 2010

(a) GDP per capita



(b) Population

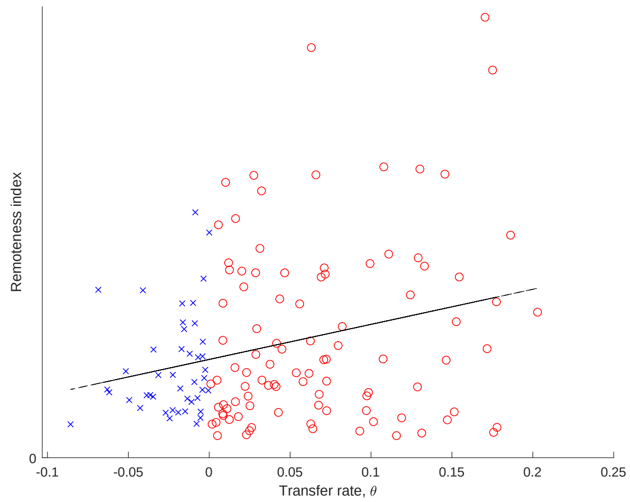


Notes: This figure plots the quantiles of the GDP per capita distribution in Panel (a) and of the population distribution in Panel (b) for the year 2010. A darker shading indicates higher values.

A.4 Remoteness

The alternative proxy for remoteness follows Baldwin and Harrigan (2011) and describes the income-weighted sum of an inverse power function of distance, according to $R(i) = (\int_N (Y(n)/dist(i,n)^{1-\sigma})dn)^{-1}$.

Figure A2: Remoteness index and the transfer rate

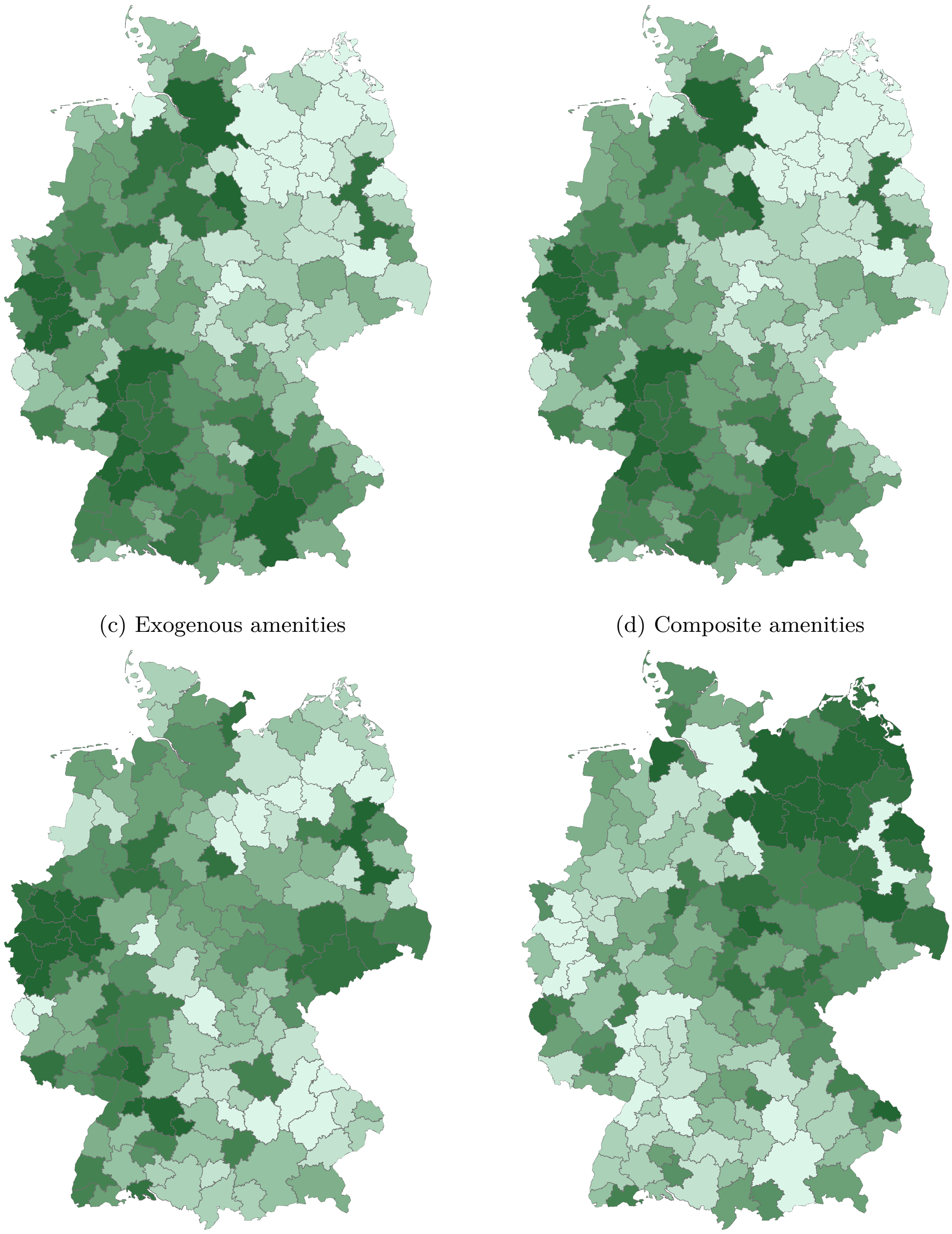


Notes: This figure depicts the level of the remoteness index against the transfer rate θ.

A.5 Robustness: Population density as a measure of the mass of workers

We repeat our main exercise using population density instead of population size as an alternative measure for the mass of workers. In our baseline scenario the qualitative and quantitative implications of abolishing fiscal transfers remain the same. Again, a total of 2.7 million individuals move from less productive towards more productive areas when fiscal transfers are abandoned. We observe an increase in average productivity by 2.6 percent and real GDP per capita by 2.6 percent at the national level. The corresponding drop in welfare is 0.07 percent after abandoning the transfer scheme. That is, $\hat{W} = -0.07$. The changes differ slightly from the counterfactual with population size as a measure of the mass of workers. The reason is that exogenous amenity and productivity levels differ slightly. The maps in Figure A3 show the patterns of exogenous and composite productivities, and the respective amenities.

Figure A3: Estimated exogenous productivities and amenities


(a) Exogenous productivities

(b) Composite productivities

(c) Exogenous amenities

(d) Composite amenities

Notes: This figure plots the exogenous and composite productivities $\bar{A}(i)$ and $A(i)$, and the respective amenities $\bar{u}(i)$ and $u(i)$ for $\alpha = 0.05$, $\beta = 0.66$, $\gamma = 0.2$ and $\eta = 0$ when we use population density instead of population size as a measure of labor $L(i)$. A darker shading indicates higher values.

PREVIOUS DISCUSSION PAPERS

322 Henkel, Marcel, Seidel, Tobias and Suedekum, Jens, Fiscal Transfers in the Spatial Economy, September 2019.

321 Korff, Alex and Steffen, Nico, Economic Preferences and Trade Outcomes, August 2019.

320 Kohler, Wilhelm and Wrona, Jens, Trade in Tasks: Revisiting the Wage and Employment Effects of Offshoring, July 2019.

319 Cobb-Clark, Deborah A., Dahmann, Sarah C., Kamhöfer, Daniel A. and Schildberg-Hörisch, Hannah, Self-Control: Determinants, Life Outcomes and Intergenerational Implications, July 2019.

318 Jeitschko, Thomas D., Withers, John A., Dynamic Regulation Revisited: Signal Dampening, Experimentation and the Ratchet Effect, July 2019.

317 Jeitschko, Thomas D., Kim, Soo Jin and Yankelevich, Aleksandr, Zero-Rating and Vertical Content Foreclosure, July 2019.

316 Kamhöfer, Daniel A. und Westphal, Matthias, Fertility Effects of College Education: Evidence from the German Educational Expansion, July 2019.

315 Bodnar, Olivia, Fremerey, Melinda, Normann, Hans-Theo and Schad, Jannika, The Effects of Private Damage Claims on Cartel Stability: Experimental Evidence, June 2019.

314 Baumann, Florian and Rasch, Alexander, Injunctions Against False Advertising, June 2019.

313 Hunold, Matthias and Muthers, Johannes, Spatial Competition and Price Discrimination with Capacity Constraints, May 2019 (First Version June 2017 under the title “Capacity Constraints, Price Discrimination, Inefficient Competition and Subcontracting”).

312 Creane, Anthony, Jeitschko, Thomas D. and Sim, Kyoungbo, Welfare Effects of Certification under Latent Adverse Selection, March 2019.

311 Bataille, Marc, Bodnar, Olivia, Alexander Steinmetz and Thorwarth, Susanne, Screening Instruments for Monitoring Market Power – The Return on Withholding Capacity Index (RWC), March 2019.
Published in: Energy Economics, 81 (2019), pp. 227-237.

310 Dertwinkel-Kalt, Markus and Köster, Mats, Salience and Skewness Preferences, March 2019.
Forthcoming in: Journal of the European Economic Association.

309 Hunold, Matthias and Schlütter, Frank, Vertical Financial Interest and Corporate Influence, February 2019.

308 Sabatino, Lorien and Sapi, Geza, Online Privacy and Market Structure: Theory and Evidence, February 2019.

307 Izhak, Olena, Extra Costs of Integrity: Pharmacy Markups and Generic Substitution in Finland, January 2019.

306 Herr, Annika and Normann, Hans-Theo, How Much Priority Bonus Should be Given to Registered Organ Donors? An Experimental Analysis, December 2018.
Published in: Journal of Economic Behavior and Organization, 158 (2019), pp.367-378.

305 Egger, Hartmut and Fischer, Christian, Increasing Resistance to Globalization: The Role of Trade in Tasks, December 2018.

304 Dertwinkel-Kalt, Markus, Köster, Mats and Peiseler, Florian, Attention-Driven Demand for Bonus Contracts, October 2018.
Published in: European Economic Review, 115 (2019), pp.1-24.

303 Bachmann, Ronald and Bechara, Peggy, The Importance of Two-Sided Heterogeneity for the Cyclicality of Labour Market Dynamics, October 2018.
Forthcoming in: The Manchester School.

302 Hunold, Matthias, Hüschelrath, Kai, Laitenberger, Ulrich and Muthers, Johannes, Competition, Collusion and Spatial Sales Patterns – Theory and Evidence, September 2018.

301 Neyer, Ulrike and Sterzel, André, Preferential Treatment of Government Bonds in Liquidity Regulation – Implications for Bank Behaviour and Financial Stability, September 2018.

300 Hunold, Matthias, Kesler, Reinhold and Laitenberger, Ulrich, Hotel Rankings of Online Travel Agents, Channel Pricing and Consumer Protection, September 2018 (First Version February 2017).

299 Odenkirchen, Johannes, Pricing Behavior in Partial Cartels, September 2018.

298 Mori, Tomoya and Wrona, Jens, Inter-city Trade, September 2018.

297 Rasch, Alexander, Thöne, Miriam and Wenzel, Tobias, Drip Pricing and its Regulation: Experimental Evidence, August 2018.

296 Fourberg, Niklas, Let's Lock Them in: Collusion under Consumer Switching Costs, August 2018.

295 Peiseler, Florian, Rasch, Alexander and Shekhar, Shiva, Private Information, Price Discrimination, and Collusion, August 2018.

294 Altmann, Steffen, Falk, Armin, Heidhues, Paul, Jayaraman, Rajshri and Teirlinck, Marrit, Defaults and Donations: Evidence from a Field Experiment, July 2018.
Forthcoming in: Review of Economics and Statistics.

293 Stiebale, Joel and Vencappa, Dev, Import Competition and Vertical Integration: Evidence from India, July 2018.

292 Bachmann, Ronald, Cim, Merve and Green, Colin, Long-run Patterns of Labour Market Polarisation: Evidence from German Micro Data, May 2018.
Published in: British Journal of Industrial Relations, 57 (2019), pp. 350-376.

291 Chen, Si and Schildberg-Hörisch, Hannah, Looking at the Bright Side: The Motivation Value of Overconfidence, May 2018.

290 Knauth, Florian and Wrona, Jens, There and Back Again: A Simple Theory of Planned Return Migration, May 2018.

289 Fonseca, Miguel A., Li, Yan and Normann, Hans-Theo, Why Factors Facilitating Collusion May Not Predict Cartel Occurrence – Experimental Evidence, May 2018.
Published in: Southern Economic Journal, 85 (2018), pp. 255-275.

288 Benesch, Christine, Loretz, Simon, Stadelmann, David and Thomas, Tobias, Media Coverage and Immigration Worries: Econometric Evidence, April 2018.
Published in: Journal of Economic Behavior & Organization, 160 (2019), pp. 52-67.

287 Dewenter, Ralf, Linder, Melissa and Thomas, Tobias, Can Media Drive the Electorate? The Impact of Media Coverage on Party Affiliation and Voting Intentions, April 2018.
Published in: European Journal of Political Economy, 58 (2019), pp. 245-261.

286 Jeitschko, Thomas D., Kim, Soo Jin and Yankelevich, Aleksandr, A Cautionary Note on Using Hotelling Models in Platform Markets, April 2018.

285 Baye, Irina, Reiz, Tim and Sapi, Geza, Customer Recognition and Mobile Geo-Targeting, March 2018.

284 Schaefer, Maximilian, Sapi, Geza and Lorincz, Szabolcs, The Effect of Big Data on Recommendation Quality. The Example of Internet Search, March 2018.

283 Fischer, Christian and Normann, Hans-Theo, Collusion and Bargaining in Asymmetric Cournot Duopoly – An Experiment, October 2018 (First Version March 2018).
Published in: European Economic Review, 111 (2019), pp.360-379.

282 Friese, Maria, Heimeshoff, Ulrich and Klein, Gordon, Property Rights and Transaction Costs – The Role of Ownership and Organization in German Public Service Provision, February 2018.

281 Hunold, Matthias and Shekhar, Shiva, Supply Chain Innovations and Partial Ownership, February 2018.

280 Rickert, Dennis, Schain, Jan Philip and Stiebale, Joel, Local Market Structure and Consumer Prices: Evidence from a Retail Merger, January 2018.

279 Dertwinkel-Kalt, Markus and Wenzel, Tobias, Focusing and Framing of Risky Alternatives, December 2017.
Published in: Journal of Economic Behavior & Organization, 159 (2019), pp.289-304.

278 Hunold, Matthias, Kesler, Reinhold, Laitenberger, Ulrich and Schlütter, Frank, Evaluation of Best Price Clauses in Online Hotel Booking, December 2017 (First Version October 2016).
Published in: International Journal of Industrial Organization, 61 (2019), pp. 542-571.

277 Haucap, Justus, Thomas, Tobias and Wohlrabe, Klaus, Publication Performance vs. Influence: On the Questionable Value of Quality Weighted Publication Rankings, December 2017.

276 Haucap, Justus, The Rule of Law and the Emergence of Market Exchange: A New Institutional Economic Perspective, December 2017.
Published in: von Alemann, U., D. Briesen & L. Q. Khanh (eds.), The State of Law: Comparative Perspectives on the Rule of Law, Düsseldorf University Press: Düsseldorf 2017, pp. 143-172.

275 Neyer, Ulrike and Sterzel, André, Capital Requirements for Government Bonds – Implications for Bank Behaviour and Financial Stability, December 2017.

274 Deckers, Thomas, Falk, Armin, Kosse, Fabian, Pinger, Pia and Schildberg-Hörisch, Hannah, Socio-Economic Status and Inequalities in Children’s IQ and Economic Preferences, November 2017.

273 Defever, Fabrice, Fischer, Christian and Suedekum, Jens, Supplier Search and Re-matching in Global Sourcing – Theory and Evidence from China, November 2017.

272 Thomas, Tobias, Heß, Moritz and Wagner, Gert G., Reluctant to Reform? A Note on Risk-Loving Politicians and Bureaucrats, October 2017.
Published in: Review of Economics, 68 (2017), pp. 167-179.

271 Caprice, Stéphane and Shekhar, Shiva, Negative Consumer Value and Loss Leading, October 2017.

270 Emch, Eric, Jeitschko, Thomas D. and Zhou, Arthur, What Past U.S. Agency Actions Say About Complexity in Merger Remedies, With an Application to Generic Drug Divestitures, October 2017.
Published in: Competition: The Journal of the Antitrust, UCL and Privacy Section of the California Lawyers Association, 27 (2017/18), pp. 87-104.

269 Goeddeke, Anna, Haucap, Justus, Herr, Annika and Wey, Christian, Flexibility in Wage Setting Under the Threat of Relocation, September 2017.
Published in: Labour: Review of Labour Economics and Industrial Relations, 32 (2018), pp. 1-22.

268 Haucap, Justus, Merger Effects on Innovation: A Rationale for Stricter Merger Control?, September 2017.
Published in: Concurrences: Competition Law Review, 4 (2017), pp.16-21.

267 Brunner, Daniel, Heiss, Florian, Romahn, André and Weiser, Constantin, Reliable Estimation of Random Coefficient Logit Demand Models, September 2017.

266 Kosse, Fabian, Deckers, Thomas, Schildberg-Hörisch, Hannah and Falk, Armin, The Formation of Prosociality: Causal Evidence on the Role of Social Environment, July 2017.
Forthcoming in: Journal of Political Economy.

265 Friehe, Tim and Schildberg-Hörisch, Hannah, Predicting Norm Enforcement: The Individual and Joint Predictive Power of Economic Preferences, Personality, and Self-Control, July 2017.
Published in: European Journal of Law and Economics, 45 (2018), pp. 127-146

264 Friehe, Tim and Schildberg-Hörisch, Hannah, Self-Control and Crime Revisited: Disentangling the Effect of Self-Control on Risk Taking and Antisocial Behavior, July 2017.
Published in: European Journal of Law and Economics, 45 (2018), pp. 127-146.

263 Golsteyn, Bart and Schildberg-Hörisch, Hannah, Challenges in Research on Preferences and Personality Traits: Measurement, Stability, and Inference, July 2017.
Published in: Journal of Economic Psychology, 60 (2017), pp. 1-6.

262 Lange, Mirjam R.J., Tariff Diversity and Competition Policy – Drivers for Broadband Adoption in the European Union, July 2017.
Published in: Journal of Regulatory Economics, 52 (2017), pp. 285-312.

261 Reisinger, Markus and Thomes, Tim Paul, Manufacturer Collusion: Strategic Implications of the Channel Structure, July 2017.
Published in: Journal of Economics & Management Strategy, 26 (2017), pp. 923-954.

260 Shekhar, Shiva and Wey, Christian, Uncertain Merger Synergies, Passive Partial Ownership, and Merger Control, July 2017.

259 Link, Thomas and Neyer, Ulrike, Friction-Induced Interbank Rate Volatility under Alternative Interest Corridor Systems, July 2017.

258 Diermeier, Matthias, Goecke, Henry, Niehues, Judith and Thomas, Tobias, Impact of Inequality-Related Media Coverage on the Concerns of the Citizens, July 2017.

257 Stiebale, Joel and Wößner, Nicole, M&As, Investment and Financing Constraints, July 2017.

256 Wellmann, Nicolas, OTT-Messaging and Mobile Telecommunication: A Joint Market? – An Empirical Approach, July 2017.
Forthcoming in: Telecommunications Policy under the title “Are OTT Messaging and Mobile Telecommunication an Interrelated Market? An Empirical Analysis“.

255 Ciani, Andrea and Imbruno, Michele, Microeconomic Mechanisms Behind Export Spillovers from FDI: Evidence from Bulgaria, June 2017.
Published in: Review of World Economics, 153 (2017), pp. 704-734.

254 Hunold, Matthias and Muthers, Johannes, Spatial Competition with Capacity Constraints and Subcontracting, October 2018 (First Version June 2017 under the title “Capacity Constraints, Price Discrimination, Inefficient Competition and Subcontracting”).

253 Dertwinkel-Kalt, Markus and Köster, Mats, Salient Compromises in the Newsvendor Game, June 2017.
Published in: Journal of Economic Behavior & Organization, 141 (2017), pp. 301-315.

252 Siekmann, Manuel, Characteristics, Causes, and Price Effects: Empirical Evidence of Intraday Edgeworth Cycles, May, 2017.

251 Benndorf, Volker, Moellers, Claudia and Normann, Hans-Theo, Experienced vs. Inexperienced Participants in the Lab: Do they Behave Differently?, May 2017.
Published in: Journal of the Economic Science Association, 3 (2017), pp.12-25.

250 Hunold, Matthias, Backward Ownership, Uniform Pricing and Entry Deterrence, May 2017.

249 Kreickemeier, Udo and Wrona, Jens, Industrialisation and the Big Push in a Global Economy, May 2017.

248 Dertwinkel-Kalt, Markus and Köster, Mats, Local Thinking and Skewness Preferences, April 2017.

247 Shekhar, Shiva, Homing Choice and Platform Pricing Strategy, March 2017.

246 Manasakis, Constantine, Mitrokostas, Evangelos and Petrakis, Emmanuel, Strategic Corporate Social Responsibility by a Multinational Firm, March 2017.
Published in: Review of International Economics, 26 (2018), pp. 709-720.

245 Ciani, Andrea, Income Inequality and the Quality of Imports, March 2017.

244 Bonnet, Céline and Schain, Jan Philip, An Empirical Analysis of Mergers: Efficiency Gains and Impact on Consumer Prices, February 2017.

243 Benndorf, Volker and Martinez-Martinez, Ismael, Perturbed Best Response Dynamics in a Hawk-Dove Game, January 2017.
Published in: Economics Letters, 153 (2017), pp. 61-64.

242 Dauth, Wolfgang, Findeisen, Sebastian and Suedekum, Jens, Trade and Manufacturing Jobs in Germany, January 2017.
Published in: American Economic Review, Papers & Proceedings, 107 (2017), pp. 337-342.

Older discussion papers can be found online at:
http://ideas.repec.org/s/zbw/dicedp.html

Heinrich-Heine-University of Düsseldorf

Düsseldorf Institute for Competition Economics (DICE)

Universitätsstraße 1 _ 40225 Düsseldorf
www.dice.hhu.de

ISSN 2190-9938 (online)
ISBN 978-3-86304-321-6