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Fiscal Federalism and Risk Sharing in Germany: the Role of Size Differences

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ABSTRACT

Fiscal Federalism and Risk Sharing in Germany: the Role of Size Differences

by Kai A. Konrad and Helmut Seitz[*]

We study the effect of size differences for an optimal risk sharing system of intergovernmental transfers in Germany. The German fiscal transfer system should account for the fact that an optimal insurance mechanism has the property that smaller states contribute a smaller share of their tax revenue to the redistribution mechanism.

Keywords: Fiscal federalism, risk sharing, size asymmetry
JEL classification: D70, H41, H77

ZUSAMMENFASSUNG

Risikokonsolidierung im Rahmen des deutschen Länderfinanzausgleichs: die Rolle von Größenunterschieden

Wir betrachten die Rolle von Größenunterschieden von Gebietskörperschaften für einen optimalen Risikoausgleich im Rahmen eines föderalen Finanzausgleichs in Deutschland. Zunächst wird der Spielraum für einen möglichen Risikoausgleich durch interregionale Ausgleichszahlungen zwischen Gebietskörperschaften in Deutschland analysiert. Es zeigt sich, dass unsystematische Risiken insbesondere aus längerfristigen Entwicklungsunterschieden bestehen. Für das optimale Transfersystem sollte angesichts möglicher Anreizwirkungen solcher Systeme gelten, dass homogene Gebietskörperschaften einen um so größeren Anteil ihres Steueraufkommens in das interregionale Transfersystem einbringen sollten, je größer sie sind.

1 Introduction

The literature on fiscal federalism has extensively discussed federal transfer systems. As Musgrave (1961) has pointed out in the introduction to his seminal paper on *Approaches to A Fiscal Theory of Political Federalism*, there are many possible reasons why the central government in a federation may interfere with state finances. The complexity of actual transfer arrangements reflects the multiplicity of reasons for such transfers.[1] Musgrave (1961) distinguishes several objectives. First, the central government may try to influence the amount or type of public services, or the terms on which public services are provided at the state level. Second, the federal government may try to make a citizen's situation in terms of public services more independent of the state to which the citizen belongs to. All these objectives may be at work in the German case, where not only are state and federal revenues redistributed according to a complex scheme, but the provision of public services by states and by the federal government is also highly integrated. Very recently the German Supreme Court has demanded a major reform of this system.

A central aspect that provides legitimation for a system of unconditional transfers between states in a federation[2] is idiosyncratic regional risk and the potential for intergovernmental risk sharing. We will concentrate on this aspect here. The potential for risk sharing in federations is a hotly debated issue. Of course, like any risk sharing device, risk sharing between regions involves some problems of moral hazard.[3] Mutual insurance among states against random variations in the provision of public services would be provided by ex-post equalization of actual outlays or performance. As Musgrave (1961) pointed out when discussing equalization of actual outlays or perfor-

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[1]Sometimes this is a scheme in which regions redistribute some share in their government budgets among themselves. Sometimes the redistribution occurs via regional contributions to a federal layer of government, or via the way the federal government allocates revenues that stem from all regions for purposes that benefit some regions more than others, or both. Transfer systems become even less transparent through matching grants provisions and other joint funding of regional expenditure. Also, there seems to be a tendency for the complexities of these transfer mechanisms grow over time. Hence, it may be not an accident that the German system is particularly complex, as it has been in place now for 50 years. Another example is the EU budget, particularly the complication that is introduced by the special provisions for the U.K. and the way these have developed from one reform to the next (see, e.g., Messal and Klein, 1993).

[2]As has been discussed in the literature on fiscal federalism, conditional transfers or matching grants play a major role in internalizing interregional spillovers. See, for example, Oates (1972).

[3]There may also be issues of adverse selection, and several papers, e.g., by Cremer and Pestieau (1997), Bordignon, Manasse and Tabellini (2001), Cornes and Silva (2000) consider this aspect.

mance, fiscal equalization systems that force regions with above average per capita tax revenues to pay transfers to regions with below average fiscal capacity generate strong disincentives for tax revenue generating policies in both fiscally weak and fiscally strong regions.

A large number of recent contributions has addressed the fundamental trade-offs between risk sharing, redistribution between regions that differ with respect to their expected wealth, and incentives.[4] This paper revisits the fundamental trade-off between risk sharing and incentives for local governments. Much of the literature has focused on federal transfers as a risk sharing device to smooth private consumption (see, e.g., Fatás (1998) and Forni and Reichlin (1999) for two views and brief surveys on the empirical literature). We concentrate on risk sharing of government revenues, and leave private sector risks aside. This choice is made for two reasons. First, we can expect that global private capital markets can take care of risks in the private sector much better than any smoothing via countercyclical taxation and the insurance effect of tax transfers within a federation, because it encompasses a larger set of risky assets that involve idiosyncratic risks.[5] This argument is stronger the smaller the federation under consideration, and hence particularly relevant for a federation such as Germany that represents only a small share in global economic activity. Second, it is known that government revenue is more volatile than aggregate income itself. Hence, governments' revenue risks are of particular relevance.

The central aspect we address is *asymmetry in regions' population size*. All existing federations are composed of regions of asymmetric population size. Differences in size within Germany are almost as dramatic as in the EU[6]. For instance, the largest state in 1999, North Rhine-Westphalia, had 18m inhabitants which is 27.1 times the size of the population of Bremen, the smallest state in terms of population size, which had a population of 0.66m. The second-largest state, Bavaria, had 12.1m inhabitants, which is 11.4 times the size of the second smallest state, Saarland, which had a population of 1.07m. Suppose two states form a federation, one state A about ten times the size of the other state B. Neglecting the issue of moral hazard, the best

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[4]See, for instance, contributions by Bucovetsky (1997, 1998), Lee (1998), Alesina and Perotti (1998) and Persson and Tabellini (1996a, 1996b) and Lockwood (1999).

[5]For instance, Asdrubali, Sørensen and Yosha (1996) estimated that in the US in the period from 1964 to 1990 private capital markets and credit markets account for 39 and 23 percent of total consumption smoothing, respectively, compared to a contribution of 13 percent by the federal fiscal transfer system.

[6]In the European Union, the largest country (Germany) has about 200 times the population size of the smallest country (Luxembourg), and the second-largest country (France) has more than 16 times the size of the second-smallest country (Ireland).

mutual insurance outcome would be obtained if both states collect their risky tax revenue, sum up their tax revenues and divide this total sum between them (not necessarily evenly). However, moral hazard incentives on the side of states would typically make this maximum mutual insurance suboptimal. With revenue sharing, each state's incentive to enforce the (uniform federal) tax laws and to spend money on tax auditing is diminished. In this paper we consider linear mutual insurance schemes. We characterize the optimal linear mutual insurance scheme.[7] We show that the per capita share of a region's tax revenue that should enter the insurance scheme is higher the larger the relative size of this region. Further, even though the optimal insurance scheme has larger contributions by larger regions, which increases their moral hazard incentives, it holds that, for optimal contribution shares, the larger region chooses higher per capita tax revenue than the smaller region.

In what follows we first briefly survey the empirical literature on risk sharing in federations, consider whether there is scope for risk sharing within a federation such as Germany (which could possibly justify some of the federal transfer mechanism that exists under the current law), and survey the incentive properties of the current system of federal transfers in Section 2. Then we establish the main results regarding the impact of relative size on the optimal mutual insurance contract within a federation in Section 3 and draw conclusions for the optimal design of the federal transfer system.[8] Section 4 summarizes the findings and concludes.

2   Empirical evidence

To assess the importance of size effects in the trade-off between risk sharing and the disincentive effects of mutual insurance arrangements in a federal system of taxes and transfers as in Germany, we consider two types of evidence. We consider the scope for risk diversification in federations, and we consider how size affects the incentive effects of a proportional redistribution mechanism.

Whether region specific (idiosyncratic) economic performance risk in federations is of major importance, and whether federal tax-transfer systems can

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[7]Existing federations are more likely to be a political economy outcome than the outcome of a welfare maximization calculus. However, the efficient allocation is of some interest as a benchmark case. One may then ask why actual political outcomes deviate from this efficient outcome.

[8]Our aim is not to draw conclusions about whether existing federal transfer mechanisms redistribute too much or too little. Instead, we derive an optimality property by which regions' contribution shares should be differentiated according to relative size.

provide a quantitatively important amount of insurance is a debated issue. The empirical literature mainly concentrates on the effect of federal taxation on consumption risk in the EU, the US, and Canada, and, for assessing the scope for interstate insurance in Germany, we may follow the general insights from this literature.

Fatás (1998), for instance, examined GDP growth rates across US states from 1969 to 1990. He calculated standard deviations ranging from 10.36 (North Dakota) to as low as 1.64 (Pennsylvania) with an average of 2.17. Standard deviations relative to the aggregate were between 6.53 (North Dakota) and 0.96 (Pennsylvania), with an average of 1.36. Finally, correlations of growth rates with the average growth rate (of all states in the federation, excluding the particular state under consideration) ranged between 0.13 (Wyoming) and 0.93 (Ohio) with an average of 0.72. Fatás (1998) also compares these values with the EU countries. There, for the pre EMU period from 1979 to 1996, the standard deviation of growth rates had an average of 1.71, the average of standard deviations relative to the aggregate was 1.41, and the average correlation was 0.56. He then considers the consumption smoothing that was generated by federal taxation. Consumption smoothing via federal tax and transfer systems can be attributed to two effects: interregional smoothing (sharing of idiosyncratic variations of state tax bases) and intertemporal smoothing (sharing fluctuations of the aggregate tax base over time). Only the first effect is the "insurance effect" of federal tax-transfer systems. The second effect is called "substitution effect". Fatás argues that the insurance effect contributes most to explaining consumption smoothing if there is no variation in growth rates in the aggregate over time, but much variation in growth rates across regions within each period. Similarly, consumption smoothing can mainly be attributed to intertemporal smoothing, and not to an insurance effect if growth rates across regions within periods are highly correlated, and if there is considerable variation in the aggregate growth rate over time. The insurance effect contributes little to consumption smoothing if the growth rates fluctuate much over time and are highly correlated across states, and the insurance part of consumption smoothing is large if there is little intertemporal variation in growth, but large variation across states. For the US, Fatás concludes that federal taxation smoothes consumption, but that 2/3 of this effect should be attributed to intertemporal tax smoothing, and only about 1/3 of the effect should be attributed to an insurance effect.

State	σ_i	$\sigma_i/\bar{\sigma}_i$	Corr
N R-P	1.922	0.995	0.951
Bavaria	1.884	0.977	0.953
BW	2.331	1.263	0.934
L-Sax	1.901	0.880	0.890
Hesse	2.377	1.264	0.882
R-P	2.009	1.053	0.929
SH	1.932	0.993	0.625
Saarland	1.976	1.033	0.772
Hamburg	1.922	0.886	0.714
Bremen	1.905	0.740	0.780
average	2.073	1.073	0.933

Table 1. Volatility and correlation of real GDP growth rates 1971 - 1999 of states in West Germany (excluding Berlin-West). σ_i denotes the standard deviation of real GDP growth rate of state i. $\bar{\sigma}_i$ denotes the standard deviation of real GDP growth in West Germany (excluding state i). Corr denotes the correlation coefficient between the real GDP growth rate of state i and real GDP growth rate in West Germany (excluding the state i). (Calculated from *Volkswirtschaftliche Gesamtrechnung der Länder*.)

In the light of these results, the respective data on West Gemany in Table 1 draw a gloomy picture about the possible benefits of interregional insurance. The average standard deviation in Germany is in the same range as in the US or in Europe, but the correlation of states' growth has been much larger in Germany than in the US or across EU countries. Fatás' (1998) verdict on the role of insurance in consumption smoothing would therefore apply even more strongly for Germany: the share of the "insurance effect" for consumption smoothing in Germany would be very small.

Forni and Reichlin (1999) review the results that point to insurance effects being of little importance. They argue that autocorrelation of regional growth can change these results: regions can take care of high frequency changes in growth performance by intertemporal smoothing, particularly borrowing and lending, and this is true for both the private and the public sectors. Hence, the main purpose of insurance via federal taxation is to insure against long lasting shocks, that is, states would like to insure their citizens against long lasting changes in economic performance, relative to other states.[9]

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[9]Such insurance need not be desirable in a world with perfectly mobile citizens, because it reduces migration and prevents individuals from making use of productivity differences. However, mobility is rather imperfect. If we assume that the migration cost for the old

Indeed, in Germany there is some evidence that such long term changes in regional prosperity do exist. For instance, as reported in Färber (1998, p. 112), Bavaria had a much steeper growth path than all other states in Germany. In 1950 per capita GDP in Bavaria was about 87 percent of average per capita GDP in Germany and this ratio increased to about 108 percent in 1997. Similarly, Hesse moved from 99.3 percent in 1950 to 123.6 percent in 1997, whereas relative per capita income in North Rhine-Westphalia dropped from 120.2 percent in 1950 to 93.9 percent in 1997. Hamburg shows a U-shaped pattern, starting from 186.2 percent of average GDP per capita in 1950, dropping to 162.2 percent in 1990, and rising again to 176 percent in 1997. Figure 1 depicts these changes for all West German states.[10] For the tax revenue, changes can be expected to be even more pronounced, as the progressivity of many taxes lead to a more than proportional reaction of tax revenue to changes in the tax base. Because government revenue is strongly procyclical with GDP growth, any random shock on GDP growth is magnified with respect to growth rates, and hence, this risk may be larger than the variation in GDP.

This suggests that there is some long run variation in tax bases across German states, leaving some scope for an insurance motive in the federal tax-transfer system. Of course, we should note that there are some caveats. The long term changes in performance are only partially the outcome of exogenous developments. First, the federal system, in which considerable interaction between states occurred both in terms of tax revenue sharing and in terms of public service provision, may have had an impact on regional growth and development. It is likely that this interaction had an equalizing effect, so that the variation in Figure 1 may understate the exogenous risks.

Second, regional growth and development depends on factors such as regional investment, and other regional policy. Regional investment along relevant dimensions (infrastructure, human capital) may have been higher in the states that outperformed other states, or these states may simply have had better government. However, there are also some seemingly exogenous developments that can be seen as 'natural' explanations for the most notable changes that occurred in Bavaria, Hesse, North Rhine-Westphalia, Hamburg and Bremen. For instance, North Rhine-Westphalia, Hamburg and Bremen

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generation is prohibitive, but the young can migrate, the exodus of the young may actually aggravate economic shocks. Migration cannot be expected to work as an instantaneous buffer. Adjustment to permanent changes in productivity takes time, leaving a considerable role for insurance against long lasting shocks.

[10]The former Berlin (West) is not included in the empirical stocktaking because Berlin (West) and Berlin (East) merged in 1990 to form the state Berlin and therefore consistent time series data on Berlin are not available.
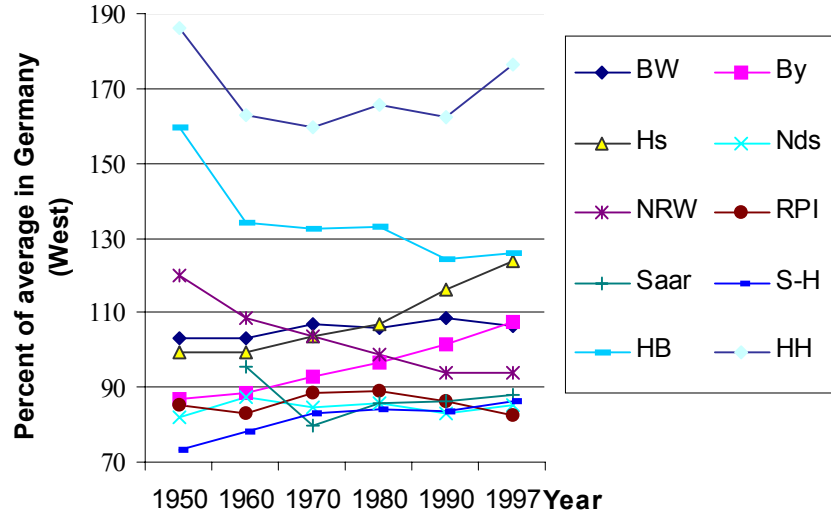
Figure 1: Regional long term economic performance risks in Germany (data source: Färber, 1998).

were "rich" in the fifties, because the former state had a lot of mining and iron and steel industries and the latter two had a lot of ship building industry. The global crisis in recent decades in these industries had not been anticipated in the fifties by most economists. Similarly, the tremendous importance of fashion, media, communication, air transport, and the financial sector in the nineties that contributed to the economic prosperity increase in Bavaria and Hesse were also not anticipated by many economists in the fifties.

A second issue that has to be addressed is whether size differences between the German states really matter. Table 2 presents several measures. Column 1 simply presents state population which indicates rather dramatic differences in population size across states. Column 2 presents the population share of the various states. With a per capita uniform transfer mechanism, this relative size is a measure of how much returns to a state in terms of transfers if the state raises its tax base by one additional Deutschmark, if this Deutschmark fully enters into the transfer system. Column 3 reports the implicit tax rate, ITR_{100}, if all tax revenues are taken into account in the fiscal equalization system. For comparison, column 4 reports the implicit tax rate if only 90% of state tax revenues enter the fiscal equalization system, ITR_{90}. The final column, MTR, reports the implicit marginal tax rates for the actual federal tax-transfer mechanism that operated in Germany, based on 1996 data reported in Baretti et al. (2000). Simple eyeballing reveals

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that there is a close relationship between ITR_{90} and MTR. This is not an accident. The German federal tax-transfer system is rather complex, and consists of a number of steps involving both interstate equalization of tax revenues and further equalizing transfers from the federal government to the states.[11] However, an important element is that a major share of VAT taxes and federal transfers are used to equalize more broadly defined tax revenues per capita (including revenues from income taxation and some others, but not all state revenues), and we can expect that this effect contributes to making ITR_{90} and MTR rather similar.

States	n_i	$\frac{n_i}{\sum n_j}$	ITR_{100}	ITR_{90}	MTR
N R-W	18.000	0.219	0.781	0.703	0.712
Bavaria	12.155	0.148	0.852	0.767	0.745
BW	10.476	0.128	0.872	0.785	0.755
L-Sax.	7.899	0.096	0.904	0.814	0.851
Hesse	6.052	0.074	0.926	0.833	0.798
Saxony	4.460	0.054	0.946	0.851	0.898
R-P	4.031	0.049	0.951	0.856	0.872
S-A	2.649	0.032	0.968	0.871	0.909
S-H	2.777	0.034	0.966	0.869	0.878
Thur.	2.449	0.030	0.970	0.873	0.910
Brand.	2.601	0.032	0.968	0.871	0.910
M W-P	1.789	0.022	0.978	0.880	0.914
Saarland	1.072	0.013	0.987	0.888	0.919
Berl.	3.387	0.041	0.959	0.863	0.898
Hamburg	1.705	0.021	0.979	0.881	0.914
Bremen	0.663	0.008	0.992	0.893	0.916

Table 2. n_i = Population in state i in 1999 (source: Statistisches Bundesamt), $n_i/\sum n_j$ = population in state i as a share of aggregate population, ITR_{100}= $1 - n_i/\sum n_j$ is the implicit tax rate that results from a federal redistribution system if all state tax revenues are summed up and shared evenly on a per capita basis. $ITR_{90} = (0.9)(1 - n_i/\sum n_j)$ is the respective implicit tax rate that results from a federal redistribution system if 90 percent of all state tax revenue are summed up and shared evenly on a per capita basis.[12] MTR is the marginal tax rates on state tax revenue in Germany (the net outflow share from

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[11]Another major element of interregional redistribution in Germany is social insurance. As we consider government budgets, and these systems are organized independently and are not part of the government budget in Germany, we disregard these types of redistribution.

[12]ITR_{100} and ITR_{90} correspond to $\gamma = 1$ and $\gamma = 0.9$ in the section 3 below.

an increase in income tax revenue in state i by one million DEM) as reported in Baretti et al. (2000, p. 106) on the basis of actual data in Germany for 1996.

Table 2 shows that size differences generate substantially different marginal incentives for generating tax revenue for the different German states. States in Germany audit and enforce the tax laws. Most of these tax laws are uniform throughout the federation. However, states have some discretion as to how strictly they enforce tax laws, and how much they spend on monitoring and auditing, and the implicit tax rates may influence these decisions.[13]

Now we turn to the theoretical aspects of size differences in a mutual insurance scheme between states in a federation.

3   Optimal insurance

Transfer schemes in federations are typically symmetric, in the sense that all states in the federation participate with the same share in their government revenues in the tax-transfer scheme. In this section, we will highlight that this is suboptimal. The optimal tax-transfer mechanism should account for relative size. We consider the role of population size for the optimal mutual insurance contract in a simple framework.

Consider a federation that consists of two states, A and B. The states are inhabited by n_A and n_B identical individuals, respectively, with $N = n_A + n_B$ being the total number of individuals. There is no information asymmetry between individuals and the state government so that the governments behave in the best interest of their citizens.[14] Simplifying as much as possible, the utility of a citizen in region i is described by

$$u_i = \theta E g_i - \beta S(g_i) - \varphi(e_i) \tag{1}$$

with g_i the per capita amount of a publicly provided good in region i, $E g_i$ is the expected amount of provision, $S(g_i)$ is the variance of this per capita amount and β is the relative weight of variance in units of expected amount.

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[13]Whether such disincentives exist or not is hotly debated in German politics, and essentially this is an empirical question. Some results supporting the existence of disincentive effects are presented in Baretti, Huber and Lichtblau (1999). Given the importance of this question, and the problems of measuring these effects, this question is likely to trigger more empirical work in the future.

[14]This assumption is for simplicity here, as we concentrate on a simple point which would also emerge if we chose a political economy approach.

The factor θ measures the marginal utility of a unit of expected public provision of goods in units of private income, and we assume $\theta > 1$. The term $\varphi(e_i)$ measures the cost of taxation and will be explained in detail below.

The per capita amounts of a publicly provided good are determined as follows. The two governments' tax collections per capita are e_A and e_B. In addition to these amounts, they receive random per capita revenues ε_A and ε_B. These random variables have mean zero and variance σ^2. They are perfectly correlated between citizens of the same state. They may or may not be correlated across the two states, and the covariance is $cov(\varepsilon_A, \varepsilon_B) \equiv \rho^2$. We can think of ε_i as consisting of a state specific shock and a federation wide shock, e.g., in terms of random variation of the statutory tax base, or of random factors that determine the tax collection cost. Each state government learns the value of its own state specific shock after their collection efforts are already chosen.[15] Once e_i and ε_i are determined, their sum $(e_i + \varepsilon_i)$ becomes publicly observable.

Consider now the term $\varphi(e_i)$. This term measures the individuals' cost of governmental revenue collection activity in units of private income. For instance, this cost is the tax burden itself that reduces private consumption, but also the excess burden that is caused by distortionary taxes, and the cost of monitoring and enforcing the tax laws. In line with standard results on the cost of taxation, this cost is assumed to be strictly convex, that is, $\varphi' > 0$, $\varphi'' > 0$. We also assume convex marginal cost, $\varphi''' \geq 0$. This assumption is mainly for analytical convenience. This assumption is well known from standard moral hazard models (see Laffont and Tirole 1993).

Note that all regions are symmetric with respect to preferences of individuals, tax collection cost per capita, etc. We disregard, for instance, the issue of wealth per capita differences in different regions that have been the focus of recent interest in the literature. The only asymmetry we consider is that states differ in population size.

There is a redistribution mechanism of tax revenues between the states that provides mutual insurance. We denote $(1 - \gamma_i)$ the share of revenue that remains with the state, and γ_i the share of region i's tax revenue that enters the mutual insurance mechanism. Then we obtain

$$g_i = (1 - \gamma_i)(e_i + \varepsilon_i) + \sum_{k=A,B} \gamma_k n_k (e_k + \varepsilon_k)\frac{1}{N} \tag{2}$$

Hence, we assume that the payments that enter the redistribution mechanism are distributed evenly over the total population. This is the case, for

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[15] Accordingly, we consider a simple moral hazard problem. A different time structure in which a region learns about ε_i before it chooses its effort e_i would be interesting as well and leads to some mechanism design issues.

instance, if the state contributions go to a central government in the federation that redistributes it among the states on a per capita basis, or if the same procedure is implemented by way of an agreement among the states. We are interested in the optimal linear redistribution mechanism here, and hence, the problem will be to determine the optimal γ_A and γ_B, and we will compare our results then with the redistribution mechanism that is at work in Germany.

Note that uniform $\gamma_i = \gamma = 1$ and $\gamma_i = \gamma = 0.9$ applied to population sizes in Germany generates the implicit tax rates ITR_{100} and ITR_{90} in Table 2. Recall that the actual redistribution mechanism in Germany yields a marginal tax burden on state tax revenue which is very closely approximated by a *constant* γ of (0.9), the same for all states, and independent of population size.[16]

It is also important to note that, with two states, the two variables γ_A and γ_B span the whole set of linear mutual insurance contracts that are budget balanced, except for a possible revenue independent transfer from one state to the other. However, given that the payoff functions as in (1) are linear in expected government expenditure, for characterizing the optimal insurance contract, the revenue independent transfer is irrelevant, and it is without loss of generality if we set this transfer equal to zero.[17]

The per capita risks in state A become

$$ S(g_A) = (1 - \gamma_A + \gamma_A \frac{n_A}{N})^2 \sigma^2 + (\gamma_B \frac{n_B}{N})^2 \sigma^2 + 2(1 - \gamma_A + \gamma_A \frac{n_A}{N})(\gamma_B \frac{n_B}{N})\rho^2, \ (3) $$

and $S(g_B)$ is obtained from (3) by replacing all subscripts A by B and vice versa.

It is important to note, however, that the point here is more general and also applies if the federal government uses the contributions in a welfarist way among the states, for instance, for the provision of a global public good

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[16]As discussed previously, the assumption that states enforce federal tax laws approximates the German system, and tax law enforcement is more centralized in many federations. However, the principal result that requires taking size differences into consideration is of more general validity and may also be applied to issues such as public goods spillovers, or fiscal externalities.

[17]Note also that, due to possible non-zero correlation in outcomes, the optimal incentive contract that determines the transfer that a region receives would be a function not only of the region's own revenues in absolute terms, but also of how the region performed compared with the revenue that is obtained in the other region. In order to make use of this type of yardstick competition, a residual claimant would be needed who receives any budget surplus/deficit. However, if the redistribution mechanism has to be budget balanced, any linear redistribution mechanism can be characterized simply by some γ_A and γ_B.

that is non-rival among all citizens, the amount of which is a function of total contributions $\sum_{k=A,B} \gamma_k n_k (e_k + \varepsilon_k)$, or for per capita contributions of publicly provided private goods.

We can now consider the problem of constitutional design and ask for the linear sharing rules (γ_A, γ_B) that maximize the sum of utilities

$$U = n_A u_A + n_B u_B \tag{4}$$

in the two states, taking into account that redistributions cannot be made contingent on states' choices of e_i, as these choices cannot be observed, due to the random shock that adds to their actual tax collection efforts.

We disregard several important issues here. First, we disregard a participation constraint for each state. This is not a major shortcoming. Given the quasi linear payoff functions, an ex ante participation constraint can always be met by appropriate outcome independent transfer payments that are determined at the constitutional stage and compensate the (large) states that lose from participating in the optimal mechanism. Second, we do not allow for endogenous formation of states. As small states have an advantage here, there would be a tendency for states to split up into smaller units. In existing federations, typically there are major hurdles that make such structural changes difficult. Third, we disregard the most important questions of the optimal size and structure of federations.[18]

The problem of finding the optimal sharing rules (γ_A, γ_B) resembles a standard insurance problem with proportional insurance with moral hazard, as in Shavell (1979). However, there are two important differences that make this problem different from a standard optimal insurance problem. First, we consider mutual insurance among a small number of agents. There is no risk neutral agent here, and also aggregate risk does not vanish. Second, and more importantly, the agents here differ in size in a non-trivial way: the problem is different from mutual insurance between two agents who differ in their wealth and in their wealth risks, because our "agents" consist of sets of individuals, and these sets differ in the number of their elements. A large region represents large aggregate income risk but also consists of a large number of persons among which risks can be shared. The number of persons matters particularly if this region shares in the risks from another region.[19]

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[18]This problem has many dimensions. For instance, there could be an optimal degree of centralization in enforcement of the tax laws. Further, idiosyncratic risk is needed to make federations optimal from a risk sharing point of view, and population size, risk preferences, and the size and correlation of state risks would be important determinants for these design questions.

[19]As is known from the Arrow-Lind theorem, or portfolio theory, it makes a difference

For any given values γ_A and γ_B, regions maximize the utility of their respective citizens by a choice of e_i, anticipating the other region's equilibrium choice and taking this choice as given. Straightforward calculations yield first order conditions for choices of e_i as

$$1 - \gamma_i + \frac{n_i}{N}\gamma_i = \frac{\varphi'(e_i)}{\theta} \tag{5}$$

for $i = A, B$. Efficient tax collection would require $\varphi'(e_i) = \theta$. The first-order conditions reveal that states choose inefficiently low tax collection if they participate in the revenue sharing mechanism. A state chooses a higher tax revenue e_i if the share γ_i of revenue that goes into the redistribution mechanism is small, and if the relative size of the state compared to the total population in the federation is large. In particular, if contribution shares γ_i are uniform across states, in expectation large states generate more revenue per capita than small states do, and we would expect that there is net redistribution from large to small states.

Here we are interested in the normative question of *optimal* contribution shares. From (5) and maximization of (4) we obtain a system of equations that characterizes the second best optimal sharing rules as follows:

$$
\begin{bmatrix}
(2\beta\sigma^2 + \frac{\theta^2 n_B}{N\varphi''(e_A)}) & -2\beta\rho^2 \\
-2\beta\rho^2 & (2\beta\sigma^2 + \frac{\theta^2 n_A}{N\varphi''(e_B)})
\end{bmatrix}
\begin{pmatrix} \gamma_A^* \\ \gamma_B^* \end{pmatrix}
=
\begin{pmatrix} 2\beta(\sigma^2 - \rho^2) \\ 2\beta(\sigma^2 - \rho^2) \end{pmatrix}.
$$

Cramer's rule yields

$$\gamma_A^* = \frac{2\beta(\sigma^2 - \rho^2)\left[(2\beta\sigma^2 + \frac{\theta^2 n_A}{N\varphi''(e_B)}) + 2\beta\rho^2\right]}{(2\beta\sigma^2 + \frac{\theta^2 n_B}{N\varphi''(e_A)})(2\beta\sigma^2 + \frac{\theta^2 n_A}{N\varphi''(e_B)}) - (2\beta\rho^2)^2} \tag{6}$$

and γ_B^* is obtained from (6) by replacing all subscripts A by B and vice versa. Note that this condition (6) explicitly determines the optimal shares only if φ'' is constant, as otherwise this is an implicit function, because the choices of effort depend on the respective shares γ_i^*.

Condition (6) reveals that the share of tax revenue that should be redistributed for risk sharing purposes is generally higher if state risks are more idiosyncratic. For instance, if $\rho = \sigma$, the state risks are perfectly correlated and risk sharing is useless. Accordingly, from (6), $\gamma_A^* = \gamma_B^* = 0$ in this case. This reproduces as a by-product the result in Bucovetsky (1997) according to which federal tax-transfer mechanisms are less attractive as an insurance

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whether the agent A who shares in the risks of another agent B is a big single investor, or whether the agent A consists of many small investors.

device if regional shocks are more strongly positively correlated. In turn, if $\rho = 0$, the condition (6) simplifies to

$$\gamma_i^* = \frac{2\beta\sigma^2}{2\beta\sigma^2 + \frac{N-n_i}{N}\frac{\theta^2}{\varphi''(e_i)}}. \tag{7}$$

For this condition it can be shown that the optimal share of tax revenue that should take part in the redistribution mechanism increases in β.

The main question we address in this paper is the impact of asymmetry in population size. The following proposition holds:

Proposition 1 $\gamma_A^* > \gamma_B^*$ if $n_A > n_B$

Proof. The denominators of γ_A^* and γ_B^* are identical. Hence,

$$\gamma_A^* > \gamma_B^* \quad \text{if} \quad \frac{n_A}{\varphi''(e_B)} > \frac{n_B}{\varphi''(e_A)}. \tag{8}$$

If $\varphi''(e)$ is constant this implies that $\gamma_A^* > \gamma_B^*$ if $n_A > n_B$ for any $\rho < \sigma$, that is, if the regions' risks are imperfectly correlated. However, the result holds more generally also if $\varphi''' > 0$. This can be shown by contradiction. Suppose $\gamma_A^* < \gamma_B^*$ and $n_A > n_B$, and hence, $\gamma_A^* n_B < \gamma_B^* n_A$, or equivalently

$$(1 - \gamma_A^* \frac{n_B}{N}) > (1 - \gamma_B^* \frac{n_A}{N}). \tag{9}$$

By the first-order conditions (5) it follows from inequality (9) that $\varphi'(e_A) > \varphi'(e_B)$, and by $\varphi'' > 0$ we have $e_A > e_B$. If $\varphi''' \geq 0$ this implies $\varphi''(e_A) \geq \varphi''(e_B)$ and hence, by $n_A > n_B$, this implies $\varphi''(e_A)n_A > \varphi''(e_B)n_B$, or $\frac{n_A}{\varphi''(e_B)} > \frac{n_B}{\varphi''(e_A)}$. This in turn implies $\gamma_A^* > \gamma_B^*$ by (8). Hence, we end up with a contradiction. $\square$

Proposition 1 has a simple intuition. In order to find the optimal γ_i's that enter the risk sharing mechanism, we have to consider the trade-off between incentives and risk sharing. Suppose, e.g., $n_A = 99$ and $n_B = 1$. If state A contributes to the redistribution mechanism, it receives back 0.99 units per unit of tax revenue, whereas B gets back only 0.01 units per unit of tax revenue. The share that is returned to the state is proportional to relative population size. Hence, for equal contribution shares, the tax collection incentives are more strongly distorted in smaller regions. At the same time, a similarly strong asymmetry as regards risk sharing does not hold. More precisely, at $\gamma_A = \gamma_B < 1$, we can change the γ_i's in a way that keeps the sum of disutilities from risk constant. It turns out that, at $\gamma_A = \gamma_B$, the sum $n_A\beta S(g_A) + n_B\beta S(g_B)$ stays constant if γ_A is increased by one

marginal unit if γ_B is reduced by precisely the same marginal unit. Hence, we have a comparative static experiment that keeps the amount of total risk cost constant and can ask how this affects the other components of overall utility. By $d\gamma_A > 0$, the region A will further reduce tax collection effort by $\frac{de_A}{d\alpha_A} = -\frac{\theta n_B}{N\varphi''}$, whereas region B will increase its tax collection effort. However, for given $\gamma_A = \gamma_B$, the tax collection effort is more distorted in the region that has fewer inhabitants by (5). Hence, if the share of tax revenue that goes into the redistribution mechanism from the smaller region is reduced, the reduction in distortion is larger than the induced increase in distortion in the larger region in which the share of tax revenue increases that enters the redistribution mechanism.

From Proposition 1, we obtain a simple rule for the design of intergovernmental transfer mechanisms on a constitutional stage. If the transfer system is motivated by risk sharing incentives, smaller regions should keep a larger share in their tax revenues than larger regions. This result is in strong contrast to the existing system of intergovernmental transfers. For instance, in Germany, states are treated symmetrically and the federal redistribution mechanism does not account for state size as is suggested by Proposition 1. Note that we do not argue for a transfer mechanism that would add to the existing system. The existing redistribution is considerable, and may or may not be too high, depending on regions' risk preferences, the amount of diversifiable risk, and on the size of distortions from moral hazard that are generated by given contribution rates. The point made in Proposition 1 is that, whatever the levels of optimal risk sharing, the optimal contribution levels are not identical for small and large regions.

The optimal mutual insurance mechanism with asymmetric population sizes has another interesting property that is stated as

Proposition 2 *If the optimal mutual insurance mechanism is implemented it holds that the larger state has the larger expected tax revenue: $e_A^* > e_B^*$ if $n_A > n_B$.*

The proof is by contradiction. Let $n_A > n_B$. Suppose $e_A^* < e_B^*$. This implies $\varphi'(e_A) < \varphi'(e_B)$, or, using (5), $\theta(1-\gamma_A^*\frac{n_B}{N}) < \theta(1-\gamma_B^*\frac{n_A}{N})$. Simplifying yields $\gamma_A^* n_B > \gamma_B^* n_A$. Inserting for γ_A^* and γ_B^* and simplifying yields

$$2\beta n_B(\sigma^2 + \rho^2) + \frac{\theta^2 n_A n_B}{N}\frac{1}{\varphi''(e_B^*)} > 2\beta n_A(\sigma^2 + \rho^2) + \frac{\theta^2 n_A n_B}{N}\frac{1}{\varphi''(e_A^*)}.$$

By $n_A > n_B$, this implies $\varphi''(e_B^*) < \varphi''(e_A^*)$, and by $\varphi''' \geq 0$ we find $e_A^* > e_B^*$ which establishes a contradiction. $\square$

Recall that, for identical shares γ_A and γ_B, the government in the state with the larger population size has a stronger incentive to collect revenue, because the share of an additional unit of revenue that is collected by this government that will be spent on this region's population is larger than the respective share of an additional unit of revenue for the smaller region. The property of the optimal mechanism that is characterized in Proposition 1 counteracts this incentive: the smaller state optimally contributes a smaller share to the redistribution mechanism than the larger state, and this reduces the moral hazard incentives of the small state and increases the moral hazard incentives of the large state, compared to equal shares that average the optimal shares. However, this process stops in an interior optimum, given the trade-off between incentives and risk-sharing, and stops short of where the two states' incentives would be equal. Hence, the optimal difference in shares is too small to overcome the effect that a smaller region receives back a smaller share of its contributions to the federal redistribution mechanism.

We briefly discuss an assumption that led to this result. The linear specification of utility and mean-variance utility is mainly for analytical convenience, and because our empirical analysis is also within a mean-variance framework. With expected utility, however, income effects matter. For instance, the two regions' choices of effort are not separable as in (5), and this adds some complexity to the model. It should be straightforward, however, that the quintessential property, according to which a smaller region's tax collecting incentives are lower than for a large region, should yield qualitatively similar results as the ones derived here.

We carried out the analysis here for the case with two regions, the same design question emerges for federations with more than two states. In general, and in particular if the correlation between states is not uniform, this problem is more complex, and the optimal mechanism will sometimes involve making one state's transfer payment a function of one other, or a group of other, states' observed total tax revenue. To analyse these more complex mechanism design questions is left to future research. However, we expect that the basic result in this paper is robust: with a uniform transfer mechanism regions face a moral hazard incentive that increases if their share in the aggregate federal revenue becomes smaller, and the federal transfer mechanism should therefore account for size in order to counterbalance this effect.

4   Conclusions

In this paper we considered the role of the German federal tax-transfer scheme as a device for revenue-risk sharing between states in Germany. We briefly

reviewed the empirical literature and the data on whether there is a role for risk sharing among German states. Piecemeal evidence suggests that there is a limited number of state-specific long lasting shocks in Germany that could generate some demand for risk sharing between state governments. We also saw that one of the properties of fiscal federalism in Germany is that states differ considerably in size, and that size matters for the states' incentives to raise revenues in a homogenous and proportional federal tax-transfer system. We then considered mutual insurance between states in a federation from a theoretical perspective, asking whether size differences matter. We found that size differences do matter. For the optimal incentive system a proportional contribution of states to the tax-transfer mechanism is suboptimal. The small state should contribute a smaller share in their per capita share of tax revenues than a large state, in order to compensate for the fact that a given share of contributions to the tax-transfer mechanism has stronger disincentive effects for a smaller state than for a larger state. However, the adjustment of contribution shares should not go so far that the marginal disincentive effects for large and small states should be the same: in the optimum, the disincentive effect for a small state should indeed be stronger than for a large state.

For the optimal design of a federal tax-transfer mechanism there are many aspects that must be taken into account, and some of these reasons may reinforce, weaken, or even overcompensate the effect derived here. However, given everything else constant, our analysis provides an efficiency reason for why small states should keep a larger share of their own per capita revenues than large states so as to optimally balance the benefits of risk sharing and the harmful disincentive effects.

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