Fiscal Equalisation:

Principles and an Application to the European Union

by

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Abstract

The paper derives a normative model for partial fiscal equalisation based on a number of axioms and makes special allowance for the existence of a specific fiscal need in the jurisdictions. A simple version of this idealised equalisation scheme relates net contributions to the equalisation funds to deviations of a jurisdiction's gross income from average gross income and a jurisdiction's specific needs from average specific needs. The theoretical model is then empirically tested for the case of the European Union using data from 1986-97. It is found that most restrictions of the model appear to hold, in particular, relatively richer countries contribute more and those with greater fiscal needs, approximated by the importance of the agricultural sector, pay less. However, in the EU, an adjustment of net payments to changes in the actual importance of the specific fiscal need for a country is lacking.

Keywords: Fiscal Equalisation, European Union

JEL-Classification: H77, H87

I. Introduction

Fiscal equalisation is an important aspect of the set-up of a multitude of forms of federal government. In setting up equalisation schemes between jurisdictions within one federation, both efficiency (insurance) and redistributive goals can be achieved. In practice, it is difficult to distinguish between those motives. A highly contested question centres on the type of fiscal equalisation that is being perceived as fair.

Like many studies involving value judgments, this paper sets out to derive an idealised fiscal equalisation scheme based on an explicit axiomatic foundation. Using explicit criteria that should be fulfilled by the final equalisation scheme is a helpful way to guide the debate. One can disagree with the axioms, but if one accepts those, one must also accept the conclusion, which we define as fair. Consequently, we attempt to apply only those axioms that have the potential for gathering widespread support.

A unique feature of our model is the incorporation of specific expenditures to cope with certain needs in the member countries of the fiscal union, which allows for a more realistic modelling of the redistribution of funds than usually employed in the theoretical literature. Fiscal equalisation is often directed at particular disadvantages of fiscal jurisdictions, which are beyond their immediate control. By directly including the idea of ‘fiscal need’, we explicitly incorporate this feature of the real world. This also makes the analysis more applicable to empirical data.

The theoretical results show that key variables for the determination of net contributions are average gross income of the union and gross income of the respective member states, as well as average gross specific expenditures and local specific expenditures by the union.

As a next step, an explicit and empirically estimable functional form is directly derived from the theoretical model. In the empirical section of the paper, this idealised model is applied to the European Union (EU) to test whether the theoretical considerations are reflected in this example of a fiscal equalisation scheme. Since member-state contribution to the EU is a hotly debated issue, being able to compare the actual distribution of funds with an ideal scheme might facilitate a rational and educated discussion.

Sometimes redistribution within the EU is portrayed as lacking all foundations for a fair system and as the unsatisfactory result of a power struggle between governments. We do not disagree with the statement that political power plays a role in determining many aspects of the equalisation scheme. However, we believe that simply dismissing the solution of such negotiations as unfair is throwing the baby out with the bathwater. As will become apparent in our empirical analysis, the EU equalisation scheme does, to a certain extent, conform to a specific version of a fair redistribution allowing for specific fiscal needs.

In the empirical part of the paper, we combine observations from EU member countries over the time period 1986 to 1997 to form a panel data set of per-capita variables. First, it is tested whether the coefficients on EU average variables are equal in absolute value to the coefficients on the member-country variables. Second, imposing this restriction and using deviations from EU average values as regressors, it is then analysed whether the empirical results correspond with the idealised theoretical model.

The final section contains a summary of the results and a brief policy conclusion.

II. Axiomatic approach towards fiscal equalisation

Fiscal equalisation[1] takes place among n jurisdictions, where $n \geq 3$. Jurisdiction i, $i = 1, \ldots, n$, is characterised by (non-negative) gross income Y_i, by certain (non-negative) expenditure E_i (= specific fiscal need), and by the (non-negative) population Z_i. Net income F_i in jurisdiction i, $i = 1, \ldots, n$, depends on gross income, expenditure and population in all n jurisdictions

(1) $$F_i = F_i\left(Y_1, \ldots, Y_n, E_1, \ldots, E_n, Z_1, \ldots, Z_n\right), \text{ where } F_i : \Re_+^{3n} \to \Re .$$

It is clearly natural to base fiscal equalisation on gross income and population. However, certain expenditure could be included separately in the fiscal equalisation scheme because of various reasons, for instance, because of external effects or an uneven distribution across jurisdictions. However, in the context of an axiomatic approach, a specific fiscal need should be assessed differently simply if this reflects the intention of the entire federation.

An equalisation method is considered which, apart from other properties, isolates each jurisdiction from certain changes in other jurisdictions.

Definition 1: An *isolating partial fiscal equalisation method* satisfies[2]

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1 The axiomatic approach towards fiscal equalization is closely related to Buhl and Pfingsten (1986, 1990, 1991). However, there exists a large strand of literature dealing with a fair distribution of funds. See, for example, Moulin (1987) and Young (1988).

2 All properties with the exception of the first property should be fulfilled for all feasible values of income, fiscal need and population. Only property (A1) considers special parameter values for the jurisdiction under consideration.

(A1) $F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)=0$ if $Y_i=E_i=Z_i=0$,

(A2) $\sum_{i=1}^{n} F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)=\sum_{i=1}^{n}(Y_i-E_i)$,

(A3) $F_i(Y_1,\ldots,Y_i,\ldots,Y_j,\ldots,Y_n,E_1,\ldots,E_i,\ldots,E_j,\ldots,E_n,Z_1,\ldots,Z_i,\ldots,Z_j,\ldots,Z_n)$

$= F_j(Y_1,\ldots,Y_j,\ldots,Y_i,\ldots,Y_n,E_1,\ldots,E_j,\ldots,E_i,\ldots,E_n,Z_1,\ldots,Z_j,\ldots,Z_i,\ldots,Z_n)$,

for all i, j, $i=1,\ldots,n$, $j=1,\ldots,n$, $i\neq j$,

(A4) $F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)=F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,\lambda Z_1,\ldots,\lambda Z_n)$,

for all $\lambda>0$,

(A5) $F_i(\tilde{Y}_1,\ldots,\tilde{Y}_n,\tilde{E}_1,\ldots,\tilde{E}_n,\tilde{Z}_1,\ldots,\tilde{Z}_n)=F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)$,

where $\tilde{Y}_j=Y_j+Y_k$, $\tilde{Y}_k=0$, $\tilde{Y}_m=Y_m$,

$\tilde{E}_j=E_j+E_k$, $\tilde{E}_k=0$, $\tilde{E}_m=E_m$, $\tilde{Z}_j=Z_j+Z_k$, $\tilde{Z}_k=0$, $\tilde{Z}_m=Z_m$,

for all m, $m=1,\ldots,n$, $m\neq j$, $m\neq k$,

for all i, j, k, $i=1,\ldots,n$, $j=1,\ldots,n$, $k=1,\ldots,n$, $i\neq j$, $i\neq k$, $j\neq k$. #

The first three properties define a pure sharing funds method. The *empty jurisdiction property* (A1) says that net income in a jurisdiction without people, as well as gross income and expenditure ought to be zero. Money should not be given to empty jurisdictions. Property (A2) highlights *total distribution of funds*. The described fiscal equalisation method is a pure sharing funds method. Thus, total income net of expenditure has to be the same before and after partial equalisation. Property (A3) states *anonymity*. The assignment of numbers to jurisdictions is irrelevant.[3]

Properties (A4) and (A5) impose restrictions on funds sharing methods. Property (A4) is *homogeneity of degree zero with respect to population*. Proportional population changes in all jurisdictions do not alter net income in any jurisdiction. Property (A5) states *independence of mergers outside the jurisdiction*. This property requires that a merger between two jurisdictions does not affect any other jurisdiction. On the one hand, this axiom is derived from the subsidiarity principle. In principle, a merger should be just an affair of the acting jurisdictions. On the other hand, property (A5) rules out strategic mergers between jurisdictions to the disadvantage of outsiders. Finally, property (A5) also ensures that rich jurisdictions are not interested in mergers of poor jurisdictions.[4]

Monotonicity of the fiscal equalisation method is required to preserve incentives and to maintain the order of jurisdictions:

Definition 2: A *monotonic* isolating partial fiscal equalisation method fulfils

(A6) $F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)$ is non-decreasing with respect to Y_j,

for all i, j, $i = 1,\ldots,n$, $j = 1,\ldots,n$,

(A7) $F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)$ is non-increasing with respect to E_j,

for all i, j, $i = 1,\ldots,n$, $j = 1,\ldots,n$,

(A8) $F_i(Y_1,\ldots,Y_n,E_1,\ldots,E_n,Z_1,\ldots,Z_n)$ is non-decreasing with respect to Z_i,

for all i, $i = 1,\ldots,n$. #

Property (A6) is *monotonicity with respect to gross income*. Property (A7) is *monotonicity with respect to expenditure*. Property (A8) is *monotonicity with respect to its own population*. Properties (A6) and (A7) ensure that net income in a certain jurisdiction is not negatively affected through the specific equalisation method employed

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[3] An approach that violates anonymity is discussed by Aczél and Pfingsten (1993).

when incomes in other jurisdictions increase and is not positively affected when fiscal needs in other jurisdictions increase. Axiom (A8) reflects a basic condition for distributional fairness. An increase in population in one particular jurisdiction should not decrease the available funds for that jurisdiction.

Using these definitions, the following main result can be derived (and is proven in the appendix).

Theorem 1: If net income functions $F_i : \Re_+^{3n} \to \Re$, $i = 1, \ldots, n$, constitute a monotonic isolating partial fiscal equalisation method for Y > E ≥ 0, i.e., if they satisfy properties (A1) till (A8), there exist functions

$$f_Y = f_Y(Y, E), \text{ where } f_Y : \Re_+^2 \to \Re,$$

$$f_E = f_E(Y, E), \text{ where } f_E : \Re_+^2 \to \Re,$$

so that, for all i, $i = 1, \ldots, n$,

$$F_i(Y_1, \ldots, Y_n, E_1, \ldots, E_n, Z_1, \ldots, Z_n)$$
$$= f_Y(Y, E)Y_i - f_E(Y, E)E_i + [(1 - f_Y(Y, E))Y - (1 - f_E(Y, E))E]z_i,$$

where $Y = \sum_{j=1}^n Y_j$, $E = \sum_{j=1}^n E_j$, $z_i = Z_i \big/ \sum_{j=1}^n Z_j$. #

The theorem states that a monotonic isolating partial fiscal equalisation method requires net income in a particular jurisdiction to depend on its own gross income, on total income, on its own expenditure, on total expenditure and on the population share. Moreover, the net income function is a linear function of the population share of the jurisdiction, and the coefficient in square brackets is determined by total income and

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[4] In Germany mergers of states matter. For example, federal grants and fiscal equalisation grants from rich states would have been reduced if Berlin and Brandenburg had merged.

total expenditure. Very small jurisdictions will take the coefficient as given since their own income and expenditure have only minor influence on the functions f_Y and f_E. As shown in the appendix, range requirements and monotonicity properties for differentiable functions f_Y and f_E can be imposed.

Corollary: If at (Y, E) the functions f_Y and f_E are differentiable, $0 \le f_E(Y, E) \le 1$, $0 \le f_Y(Y, E) \le 1$, $\partial f_Y / \partial Y \ge 0$, $\partial f_Y / \partial E \le 0$, $\partial f_E / \partial Y \le 0$, and $\partial f_E / \partial E \ge 0$ have to be fulfilled. #

A natural monotonic isolating partial fiscal equalisation method is described by the next theorem:

Theorem 2: Net income functions $F_i : \Re_+^{3n} \to \Re$, $i = 1, \ldots, n$, constitute a monotonic isolating partial fiscal equalisation method, i.e., they satisfy properties (A1) till (A8) for Y > E ≥ 0, if for all i, $i = 1, \ldots, n$,

(2) $$F_i(Y_1, \ldots, Y_n, E_1, \ldots, E_n, Z_1, \ldots, Z_n)$$
$$= cY_i - dE_i + \left[(1-c)\sum_{j=1}^{n} Y_j - (1-d)\sum_{j=1}^{n} E_j\right] \frac{Z_i}{\sum_{j=1}^{n} Z_j},$$

where the real numbers c and d fulfil $0 \le c \le d \le 1$. #

Proof: Equation (2) satisfies (A1) till (A5). (A6) is guaranteed by $0 \le c \le 1$. $0 \le d \le 1$ ensures (A7). (A8) is ensured by $c \le d$ since Y > E. QED

However, not only (2) is a monotonic isolating partial fiscal equalisation method. For instance, the following scheme also fulfils properties (A1) till (A8) (see the appendix for the monotonicity properties), provided that Y > E ≥ 0,

(3) $$F_i = (Y - E)z_i + \frac{\arctan(Y)}{\pi}(Y_i - Yz_i) - \frac{\arctan(E)}{\pi}(E_i - Ez_i),$$

where Y, E and z_i are defined as in theorem 1.

With respect to gross income and population, the partial equalisation method (2) has been suggested by Buhl and Pfingsten (1991).[5] Neglecting expenditure (and also federal funds which have been considered by Buhl and Pfingsten), a comparison of the two approaches is worthwhile. Properties total distribution (A2), anonymity (A3), homogeneity of degree zero with respect to population (A4), independence of mergers outside the jurisdiction (A5), and monotonicity with respect to gross income (A6) and population (A8) are common axioms. The empty-jurisdiction property (A1) is not explicitly stated in Buhl and Pfingsten (1991). They, however, require additionally what they call independence of the length of the equalisation method and independence of population distribution. While the former property is formally (adapting our notation to the case without expenditure)

$$(4) \qquad F_i\left(\hat{Y}_1,\ldots,\hat{Y}_n,Z_1,\ldots,Z_n\right)+F_i\left(Y_1,\ldots,Y_n,Z_1,\ldots,Z_n\right)$$
$$= F_i\left(Y_1+\hat{Y}_1,\ldots,Y_n+\hat{Y}_n,Z_1,\ldots,Z_n\right),$$

the latter property requires that migration between jurisdictions should not affect the rest. Independence of the length of the equalisation method is a strong assumption which results in the sum structure with coefficients independent of total income. Due to this property, in the scenario described by Buhl and Pfingsten the equalisation method (2) is not only sufficient – as stated by the previous theorem – but also necessary.

III. Partial fiscal equalisation in the European Union

The EU is an interesting and topical testing ground for assessing the practical importance of an idealised fiscal redistribution framework. Although no explicit fiscal equalisation scheme exists in the European Union, only a small fraction of EU expenditures

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5 See also Buhl and Pfingsten (1986, 1990).

(roughly 8%)[6] is allocated to common purposes. This implies that the major part of EU expenditures directly flows back into member countries. These direct flows to and from the EU can be interpreted as reflecting a fiscal redistribution policy across member countries.[7]

An important question for the empirical analysis is the choice of an appropriate variable to capture a specific fiscal need. The EU is a very good testing ground for this reason, as it is relatively easy to determine the main fiscal need. In our view, this is the agricultural sector, as expenditures on agriculture are still the most important single item in the EU budget (51% in 1996).

The data cover the time period 1986-97 and up to 14 countries.[8] All series are in ECU and in per-capita terms.[9] Net contributions to EU are derived by subtracting direct EU payments to member countries from 'own resources' of EU by member country.[10] The importance of the agricultural sector as a special fiscal need is proxied by the ratio of gross value added of the agricultural sector (including forestry and fishing) to overall gross value added in market prices (AGR). Gross domestic product (GDP) is used as a proxy for gross income.[11] Variable names with a subscript i denote values for EU member countries and names without a subscript are average EU values.

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6 Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Technologie (1999), p. 3.

7 Some caveats of such an interpretation are listed in Bundesbank (1999), p. 65.

8 Luxembourg is excluded from the analysis as relevant data are missing. Some data on agricultural shares are missing for Greece and Portugal, reducing the number of observations from 141 to 135.

9 Data are taken from various issues of Statistisches Jahrbuch für das Ausland, which is compiled by the Statistisches Bundesamt, Wiesbaden, Germany.

10 Although the EU cannot levy its own taxes to generate revenues, it nevertheless has its 'own resources'. These consist of custom duties (17% in 1996), agricultural levies (2%), value-added tax share (48%), and GDP share (33%).

11 GNP could be considered a more appropriate income aggregate in this context. However, there are difficulties in getting consistent data for the sample period for all countries. In any case, the correlation

This section analyses empirically whether the implicit fiscal equalisation scheme in the EU is in line with the ideal scheme derived in the theoretical section.[12] For that purpose, the monotonic isolating partial fiscal equalisation method (2) with constant coefficients will be used to derive an explicit functional form.

The net income function (2) can be written as

(5) $F_i = Y_i - E_i - T_i$,

where $T_i = (1-c)Y_i - (1-d)E_i + fz_i$

where $f = (1-d)E - (1-c)Y$.

T_i is the net contribution of jurisdiction i to the equalisation funds. Dividing T_i by the population leads to the per-capita contribution

(6) $t_i = (1-c)y_i - (1-d)e_i + g$,

where $g = (1-d)e - (1-c)y$,

and per-capita variables are denoted by lowercase letters:

$$t_i = T_i/Z_i,\ y_i = Y_i/Z_i,\ e_i = E_i/Z_i,\ y = Y\Big/\sum_{j=1}^{n} Z_j,\ e = E\Big/\sum_{j=1}^{n} Z_j .$$

In words, net contributions to the EU depend on gross incomes of member states, EU income, member countries’ specific fiscal expenditures and EU specific expenditures (all variables in per-capita). Based on (6), the following empirical model is estimated:

(7) $\text{Net contributions}_{it} = \beta_1 GDP_{it} + \beta_2 GDP_t + \beta_3 AGR_{it} + \beta_4 AGR_t + \varepsilon_{it}$,

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between GNP and GDP for the countries at hand is always at least 0.99 which makes them equivalent with respect to the empirical analysis.

12 An earlier analysis by Bowles and Jones (1992) looks separately at determinants for payments to the EU budget and EU own resources without the guidance of a specific economic model.

with $E\varepsilon_{i,t} = 0$ and $Var\varepsilon_{i,t} = \sigma^2$, i country index, t time index.

Table 1 gives the results of estimating this model using ordinary least squares (OLS). The coefficients reported in column 2 are all statistically significant using the normal standard errors in column 3, and they display theoretically consistent signs. In the theoretical model, coefficients (1-d) and (1-c) have to be the same for income and expenditure on the individual and aggregate level, respectively.[13] In the empirical model, this implies testing the restrictions $\beta_1 = -\beta_2$ and $\beta_3 = -\beta_4$. The last two lines of the table report test statistics for these restrictions, and they cannot be rejected based on 'normal' standard errors (SEs).

Tab. 1: Testing restrictions on equation (6) (Observations: 135)

Variables	Coefficients	SEs	Robust SEs	Adjusted SEs
GDP_{it}	0.007*	(0.003)	(0.002)	(0.003)
GDP_t	-0.008*	(0.004)	(0.003)	(0.005)
AGR_{it}	-37.4**	(4.04)	(5.2)	(13.8)
AGR_t	29.4**	(8.12)	(9.5)	(15.0)
F-test	F(4,131)=52.22**			
R^2	0.62			
Test: $\beta_1 = -\beta_2$		F(1,131)=0.53	F(1,131)=0.36	$Chi^2(1)=0.19$
Test: $\beta_3 = -\beta_4$		F(1,131)=1.27	F(1,131)=0.99	$Chi^2(1)=0.81$

Notes: *(**) indicates significance at a 5% (1%) level.

However, there are potential difficulties related to the calculation of standard errors. A typical problem in a panel framework is a violation of the homoscedasticity assumption ($\mathrm{Var}\varepsilon_{i,t} = \sigma^2$), i.e. the variance is not constant over all values of the independent variables. Column 4 presents robust standard errors based on the procedure proposed by White (1980). The relative similarity of t-test results shows that heteroscedasticity is not a major problem here.

There is another issue related to deriving correct standard errors for variables sampled at different aggregation levels (EU aggregate vs. member country). The standard errors might be downward biased (see Moulton 1990). Appropriately adjusted standard errors are shown in the last column. Indeed, standard errors have increased but the test for equality does still not reject. Thus in the following analysis, these restrictions are imposed on the model to increase efficiency of the estimates.

In other words, deviations from the EU average are used as regressors in the final analysis. The estimated restricted model is:

(8) $$\text{Net contributions}_{it} = \beta_1(\mathrm{GDP}_{it} - \mathrm{GDP}_t) + \beta_3(\mathrm{AGR}_{it} - \mathrm{AGR}_t) + \varepsilon_{it},$$

with $\varepsilon_{it} = u_i + \nu_{it}$,

u_i unobservable individual specific effect, ν_{it} remaining disturbance.

The robustness of the estimation results is investigated by making different assumptions about the error term of model (8). The between-effects model (BE) uses only the cross-sectional variation by averaging over the time dimension for each country. OLS_1 is model (7) with the restrictions on the parameters imposed, OLS_2 includes a constant, and OLS_3 adds time dummies. Finally, FE is a fixed effects estimator (within-

[13] Another restriction in the theoretical model is that $c \leq d$. This will not hold in the empirical model, though, as in the theoretical model the coefficient refers to specific expenditures, while in the empiri-

effects estimator), which takes into account country dummies in addition to time dummies.[14]

Table 2 shows that the coefficient on GDP_{it}-GDP_t is estimated relatively robust across different specifications. In accordance with the theoretical model, we get positive estimates, most of which are significant. The results are also quite consistent across differing empirical specifications in the case of AGR_{it}-AGR_t. In all regressions except for FE, the effect is negative, as we would expect from the theoretical model, and highly significant. Even after controlling for the variations in GDP, fiscal need is a powerful determinant of fiscal equalisation flows.

Tab. 2: Explaining per-capita net contributions to EU budget

Variables	BE	OLS_1	OLS_2	OLS_3	FE
GDP_{it}-GDP_t	0.005	0.006	0.007**	0.006*	0.01**
	(0.008)	(0.003)	(0.002)	(0.003)	(0.005)
AGR_{it}-AGR_t	-40.2**	-39.1**	-37.2**	-38.5**	71.4**
	(11.1)	(4.4)	(4.1)	(4.1)	(9.5)
Constant	Yes	No	Yes	Yes	Yes
Time effects	n.a.	No	No	Yes	Yes
Country effects	n.a.	No	No	No	Yes
F-test	F(2,11)	F(2,133)	F(2,132)	F(13,121)=	F(13,108)=
	= 14.7**	= 74.8**	= 87.4**	13.8**	6.9**
R^2	0.73	0.53	0.57	0.60	0.46

Notes: *(**) indicates significance at a 5% (1%) level. R^2's are not directly comparable.

cal model the share of agriculture in gross value added is used to proxy the specific needs.

[14] See Baltagi (1995) for a discussion of different specifications for panel data models.

However, there is a clear exception from this conclusion: the FE model.[15] After including country fixed-effects, the sign of the coefficient changes. It is worthwhile to investigate the source for this sign reversal in somewhat more detail to better understand what is going on.

One can show that the parameter estimates for the country dummies are highly correlated with AGR_{it}-AGR_t (correlation coefficient is 0.90). This indicates that the fiscal equalisation scheme of the EU is geared towards compensating countries for a specific fiscal need. This explains the theoretically consistent negative coefficient obtained in the other model specifications. In the FE model the redistribution aspect is captured by the country dummies, which are time invariant. After accounting for the static redistribution captured by the dummies, the AGR_{it}-AGR_t variable picks up reverse redistribution based on the variation across time.

We would interpret this finding as follows: the political process behind the compensation of specific fiscal needs is not flexible enough to allow for a continuous adjustment in the equalisation scheme. Due to the nature of the bargaining game going on between EU member countries, it is always easier to maintain the status quo than to introduce changes (see Molle 1997).

Interpreting the empirical results within the context of our theoretical model of fiscal equalisation allows for a better understanding of this aspect of EU redistribution. The EU conforms to an ideal scheme of fiscal equalisation to the extent that GDP differences matter and so do specific fiscal needs in the form of a large agricultural burden. However, redistribution is not continuously adjusted to account for changes in actual

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[15] Employing a Hausman-test (Hausman 1978) leads to a rejection of a random-effects model in favour of the FE model ($Chi^2(2) = 84^{**}$).

fiscal needs due to frictions arising from negotiations between sovereign governments with veto power trying to protect their interests. In our view, this problem lies at the heart of many complaints about the equity of the current system.

IV. Summary and conclusion

Using an axiomatic approach, this paper derives a partial fiscal equalisation scheme that not only takes income into consideration but also allows for specific fiscal needs. The idealised theoretical model demonstrates that net contributions ought to depend on average union gross income, member states gross income, average union specific fiscal need, and members states specific fiscal needs. Although the proposed independence-of-mergers-outside-the-jurisdiction axiom does not set up a Cauchy-type functional equation for income and fiscal need in all jurisdictions, the resultant functional form of the partial fiscal equalisation mechanism is similar to the scheme developed by Buhl and Pfingsten (1986, 1990, 1991).

As a special case of our more general partial fiscal equalisation scheme, we derive a simple mechanism that relates net contributions to deviations of member state values for gross income and specific fiscal need from their respective union average that can be considered as an extension of the Buhl-Pfingsten scheme.

We apply this idealised simple mechanism of partial fiscal equalisation to the European Union (EU), employing data from 1986 to 1997 for up to 14 countries. This is a particularly useful testing ground, as one can compute net contributions from member states to the EU, and it is easy to identify the main fiscal need, which is the agricultural sector, by looking at the EU budget. In a first step, it was found that the coefficients on aggregate EU GDP (agricultural share) and member countries' GDP (agricultural share)

are of equal absolute size. This restriction is then imposed on the empirical model in the second part of the analysis.

The estimate of the effect of the deviation of individual member states GDP from EU average on net contributions is positive. Thus, relatively richer countries pay more to the EU than poorer countries, as demanded in the idealised theoretical model. For the specific need proxy, the deviation of the agricultural gross value added from EU average, we find a negative parameter in most specifications: the larger the fiscal need, the lower net contributions. The sign gets reversed, however, in the case of a model including country dummies. Our interpretation of this finding is that although there is redistribution in line with the idealised theoretical model, the EU fiscal equalisation scheme does not continuously update to changes of actual fiscal needs.

To conclude, the EU equalisation scheme does to a certain extent conform to an idealised fiscal equalisation scheme based on a number of reasonable axioms. Hence general complaints about the system being unfair are not warranted. Instead, our analysis allows a more careful identification of the deficiency. It is the lack of adjustment to a change in the relative fiscal need that prevents the system from complying with the idealised equalisation scheme at all points in time.

In our opinion, this has a lot to do with the inability of the political process to reverse the status of countries from net recipient to net contributor. Perhaps it would be a useful idea to take actual fiscal equalisation away from the political bargaining agenda and hand it over to a more automatic system or the EU Commission. Unfortunately, strong national interests guided by thinking in terms of keeping the status quo are likely going to torpedo such a suggestion.

Appendix

Proof of theorem 1

Theorem 1 will be proved step by step. From (A4) follows

$$F_i(Y_1,\dots,Y_n,E_1,\dots,E_n,Z_1,\dots,Z_n)=F_i(Y_1,\dots,Y_n,E_1,\dots,E_n,z_1,\dots,z_n).$$

Using (A5) repeatedly,

$$\begin{aligned}&F_1(Y_1,\dots,Y_n,E_1,\dots,E_n,Z_1,\dots,Z_n)\\&=F_1(Y_1,0,\dots,0,Y-Y_1,E_1,0,\dots,0,E-E_1,z_1,0,\dots,0,1-z_1)\end{aligned}$$

can be derived. Generalising this result and taking the anonymity axiom (A3) into account, one derives the following Lemma:

Lemma 1: Net income functions $F_i:\Re_+^{3n}\to\Re$, $i=1,\dots,n$ satisfy properties (A3), (A4) and (A5), only if there exists a function $\tilde{F}:\Re_+^5\to\Re$ so that for all i, $i=1,\dots,n$,

$$F_i(Y_1,\dots,Y_n,E_1,\dots,E_n,Z_1,\dots,Z_n)=\tilde{F}(Y_i,Y,E_i,E,z_i). \qquad \#$$

Because of this lemma, and because of (A2) and (A5),

$$\begin{aligned}&\tilde{F}(Y_i,Y,E_i,E,z_i)+\tilde{F}(Y_j,Y,E_j,E,z_j)\\&=\tilde{F}(Y_i+Y_j,Y,E_i+E_j,E,z_i+z_j)+\tilde{F}(0,Y,0,E,0)\end{aligned}$$

has to be satisfied. Using the empty-jurisdiction property (A1), the following Lemma can be stated immediately.

Lemma 2: Net income functions $\tilde{F}:\Re_+^5\to\Re$ satisfy properties (A1), (A2), (A3), (A4) and (A5), only if for all i, j, $i=1,\dots,n$, $j=1,\dots,n$,

$$\tilde{F}(Y_i,Y,E_i,E,z_i)+\tilde{F}(Y_j,Y,E_j,E,z_j)=\tilde{F}(Y_i+Y_j,Y,E_i+E_j,E,z_i+z_j). \qquad \#$$

Hence, the net income function $\tilde{F}$ is a generalised Cauchy function and a basic result from the theory on functional equations can be applied:

Lemma 3: Net income functions $\tilde{F}:\Re_+^5 \to \Re$ satisfy properties (A1) till (A8), only if there exist functions

$$f_Y = f_Y(Y,E), \text{ where } f_Y:\Re_+^2 \to \Re,$$
$$f_E = f_E(Y,E), \text{ where } f_E:\Re_+^2 \to \Re,$$

so that,

$$\tilde{F}(Y_i, Y, E_i, E, z_i)$$
$$= f_Y(Y,E)Y_i - f_E(Y,E)E_i + [(1-f_Y(Y,E))Y - (1-f_E(Y,E))E]z_i \,.$$

#

Proof: Starting with the previous lemma, taking monotonicity into account and applying the basic theorem on generalised Cauchy equations [see Aczél (1966), p. 215 and Eichhorn (1978), p. 51], yields

$$\tilde{F}(Y_i, Y, E_i, E, z_i) = f_Y(Y,E)Y_i - f_E(Y,E)E_i + f_z(Y,E)z_i \,,$$

where $f_z:\Re_+^2 \to \Re$. Using (A2),

$$\sum_{i=1}^{n} \tilde{F}(Y_i, Y, E_i, E, z_i) = \sum_{i=1}^{n} [f_Y(Y,E)Y_i - f_E(Y,E)E_i + f_z(Y,E)z_i] = Y - E$$
$$\Rightarrow f_z(Y,E) = (1-f_Y(Y,E))Y - (1-f_E(Y,E))E \,.$$

QED.

Proof of the corollary

If at (Y, E) the functions f_Y and f_E are differentiable,

$$\frac{\partial \tilde{F}}{\partial Y} = \frac{\partial f_Y}{\partial Y}(Y_i - Yz_i) - \frac{\partial f_E}{\partial Y}(E_i - Ez_i) + (1 - f_Y)z_i, \quad \frac{d\tilde{F}}{dY_i} = \frac{\partial \tilde{F}}{\partial Y} + f_Y,$$

$$\frac{\partial \tilde{F}}{\partial E} = \frac{\partial f_Y}{\partial E}(Y_i - Yz_i) - \frac{\partial f_E}{\partial E}(E_i - Ez_i) - (1 - f_E)z_i, \quad \frac{d\tilde{F}}{dE_i} = \frac{\partial \tilde{F}}{\partial E} - f_E.$$

Since income and fiscal need in jurisdiction i can always be chosen such that $Y_i = Yz_i$ and $E_i = Ez_i$ and z_i might be arbitrarily close to zero, from (A6) and (A7) follows $0 \le f_E(Y, E) \le 1$ and $0 \le f_Y(Y, E) \le 1$. Furthermore, since z_i and either Y_i or E_i can be set equal to zero, $\partial f_Y / \partial Y \ge 0$, $\partial f_Y / \partial E \le 0$, $\partial f_E / \partial Y \le 0$, and $\partial f_E / \partial E \ge 0$ have to be fulfilled. QED.

Monotonicity properties of (3)

If $j \ne i$,

$$\begin{aligned}\frac{\partial F_i}{\partial Y_j} &= \frac{Y_i}{\pi(1+Y^2)} + \left(\pi - \arctan(Y) - \frac{Y}{1+Y^2}\right)\frac{z_i}{\pi} \\ &\ge \frac{Y_i}{\pi(1+Y^2)} + \left(\frac{\pi}{2} - \frac{Y}{1+Y^2}\right)\frac{z_i}{\pi} \\ &\ge \frac{Y_i}{\pi(1+Y^2)} \ge 0,\end{aligned}$$

$$\frac{\partial F_i}{\partial Y_i} = \frac{\partial F_i}{\partial Y_j} + \frac{\arctan(Y)}{\pi} \ge \frac{\partial F_i}{\partial Y_j},$$

$$\begin{aligned}\frac{\partial F_i}{\partial E_j} &= -\left[\frac{E_i}{\pi(1+E^2)} + \left(\pi - \arctan(E) - \frac{E}{1+E^2}\right)\frac{z_i}{\pi}\right] \\ &\le -\left[\frac{E_i}{\pi(1+E^2)} + \left(\frac{\pi}{2} - \frac{E}{1+E^2}\right)\frac{z_i}{\pi}\right] \\ &\le -\frac{E_i}{\pi(1+E^2)} \le 0,\end{aligned}$$

$$\frac{\partial F_i}{\partial E_i} = \frac{\partial F_i}{\partial E_j} - \frac{\arctan(E)}{\pi} \le \frac{\partial F_i}{\partial E_j},$$

$$\frac{\partial F_i}{\partial Z_i} = \frac{1}{\pi}\left[(\pi - \arctan(Y))Y - (\pi - \arctan(E))E\right]\frac{\partial z_i}{\partial Z_i}.$$

The term in square brackets can be written as

$$\varphi(\Delta) = (\arctan(E) - \arctan(E + \Delta))E + (\pi - \arctan(E + \Delta))\Delta,$$

where $\Delta = Y - E \geq 0$. $\varphi(0) = 0$ obviously holds. Furthermore,

$$\frac{\partial \varphi}{\partial \Delta} = \pi - \arctan(E + \Delta) - \frac{E + \Delta}{1 + (E + \Delta)^2} \geq \frac{\pi}{2} - \frac{E + \Delta}{1 + (E + \Delta)^2} > 0.$$

Hence, $\partial F_i / \partial Z_i > 0$.

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