

DEPICTING FEDERAL FISCAL TRANSFERS¹

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Abstract:

A method is described for cartographically illustrating interstate flows of federal monies within the contiguous United States, using as data the differences between government collections and expenditures by state. It is assumed that a potential field, for which the driving potential can be interpreted as political "strength", governs movements between surplus and deficit areas. Resulting computer-drawn maps reveal Frostbelt-Sunbelt flows as well as flows toward New England and Washington State. The cumulated total movement, or flux, yields a 48-by-48 table of interstate transfers. The computer likewise maps these, the state centroids being connected by arrows whose width is proportional to the magnitude of flows.

Each year the federal government collects monies from the populace of each state, but also spends monies in these states. It is essentially impossible for these amounts to be the same in any state. There is therefore some transfer of funds from one place to another via these federal accounts. I describe here one method of illustrating these flows cartographically.

The maps are based on the difference in the amounts received by the federal government from the people in each state (the flow to Washington D.C.) and the amounts spent by the federal government (the flow from Washington D.C.) in each state (4, p. 881). These interstate flows are only a small fraction (less than 5 percent) of the totals involved, and are also subject to large errors of estimation and interpretation. For related studies see Mushkin (7, 8), Labovitz (8), the Upper Midwest Economic Study (11), Browning (1), Sayler (9), and Jusenius and Ledebur (5). Particular care must be taken in reading these maps. The estimation errors are not shown on the maps, and the data are for only one time period.

The available data are the differences between income and outgo. A simple cartographic depiction would thus consist of plus or minus signs of varying magnitude or quantity in each state, or of a choroplethic shading, as in the *Atlas of California* (2, p.47). It is more challenging to try to impute the pattern of interstate flows from these data. In order to do this, I assume that the shortfall or excess is uniformly distributed over the territory of each state, obviously only an approximation, and that the movement between these depletion and accumulation areas is governed by a potential field. This last postulate is equivalent to an assertion that the funds are transferred in a geographically efficient manner and therefore that the potential satisfies Poisson's equation:

$$\Delta^2 Q = p(x, y),$$

where $p(x,y)$ is the source density field, in $\$/\text{km}^2$, of the distributed "sources" and "sinks" in the country. $Q(x,y)$ is the driving potential, and might be interpreted as political "strength." The simplest boundary condition occurs when the system is closed; thus there is no international transfer of funds, (which is not quite true, of course). This closure requires that $\partial Q/\partial \theta = 0$ on the boundary of the country.

The entire flow pattern has been estimated for the contiguous United States. Computationally a 61-by-95 finite difference mesh approximates the area of the country, somewhat crudely. This yields a system of 5,795 simultaneous equations, which can be solved by a relaxation technique. The procedure is well described in Forsythe and Wasow (3). The resulting potential and its gradient field are shown in Figure 1, as drawn by one of my computer programs. The estimated movement pattern is more clearly seen in Figure 2, even though the mean resolution of circa 400 km does not permit much detail. The streaklines are obtained by connecting the gradient vectors of Figure 1, by an algorithm described in Whittaker (13). It is apparent that the boundary condition has been only approximately satisfied; a more refined computation with a more careful treatment of the U.S. outline could overcome this problem. Assuming that the United States comprises a homogeneous transportation space is clearly an over-simplification; for example, the path through the Upper Peninsula of Michigan should probably be more restricted. Clearly, the results must be interpreted as

possible average movements. But the pattern does not appear to be one of random flow. Frostbelt to Sunbelt movement is revealed, and also a flow to New England and a latitudinal flow toward Washington state. These maps may also be compared to maps of United States population movement as given in Tobler (10), which they largely resemble.

By cumulating the total movement, or flux, across each of the state boundaries, I obtain a 48-by-48 table of estimated interstate transfers. This table is represented graphically by the computer-drawn map in Figure 3. On this map the state centroids are connected by arrows whose width is proportional to the magnitude of the flow between the adjacent states. All flows below the average flow volume have been deleted for map clarity. It can be demonstrated that this is the optimum cut-off level; it removes as many arrows as possible while minimizing the amount of flow that is suppressed.

It would be correct to assert that, if states transferred funds in the direct manner depicted, the result would be the same (from an accounting point of view) as what was being done by the federal government in this particular interval of time. It would probably be incorrect to infer that this is an effect the federal government is consciously trying to achieve, to the extent that governments can be conscious at all.

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Figure 1. Estimated field of net fiscal transfers via federal accounts, 1975. The potential field, obtained as the solution of Poisson's equation, is indicated by contour lines. The gradient field is shown by flow vectors.

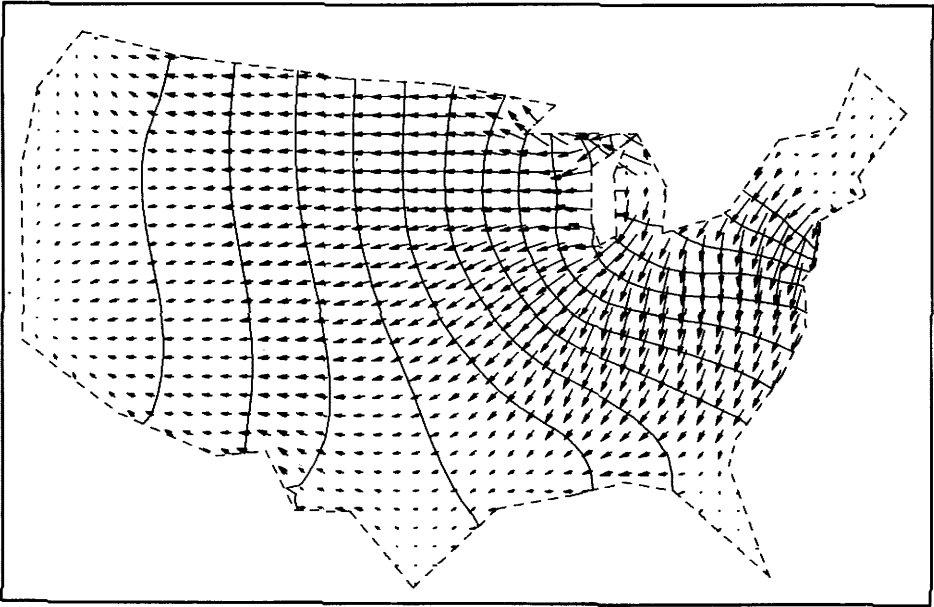


Figure 2. Estimated trajectories of the fiscal transfers. Streaklines showing the theoretical paths as computed from the potential field shown in Figure 1.

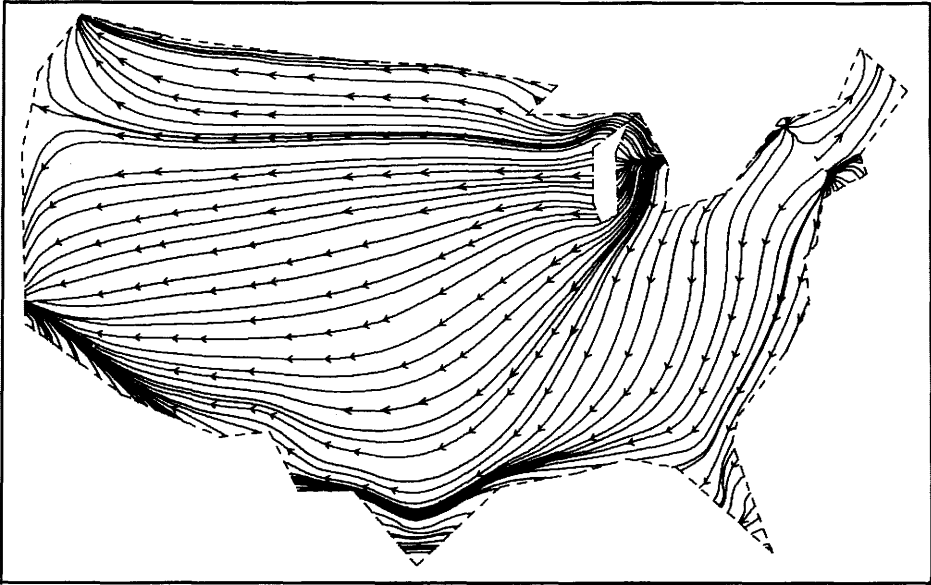


Figure 3. Estimated net interstate fiscal transfers. Obtained by aggregation of the flows shown on the previous two maps.

