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The geographic movement of wealth in the United States

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ABSTRACT A numerical model applied to the density and the flow of wealth in the United States in 1970 and 1976 shows that wealth moves with people. The maps presenting this flow resemble those of the net population movement at the same period.

• NUMERICAL MODEL • POPULATION • UNITED STATES • WEALTH

RESUME Un modèle numérique appliqué aux densités et aux flux de richesses aux Etats-Unis en 1970 et 1976 tend à montrer que ces richesses se déplacent avec la population. Les cartes illustrant ces flux sont proches de celles du mouvement net de population aux mêmes dates.

• ETATS-UNIS • MODELE NUMERIQUE • POPULATION •RICHESSES

RESUMEN Un modelo numérico aplicado a los flujos de rentas en Estados Unidos en 1970 y 1976 tiende a mostrar que éstas transitan con la población. Los mapas ilustrativos de dichos flujos se asemejan a los del movimiento neto de población en las mismas fechas.

• ESTADOS UNIDOS • MODELO NUMERICO • POBLACION • RENTAS

Wealth can be created, destroyed, and moved from place to place. Actual from-to tables of the geographical movement of wealth between places are however very difficult to find, much more difficult than locating simple estimates of the amount of wealth at different places. The approach taken here is to attempt to infer the geographic flow pattern by looking only at the changes in wealth. As a specific example, in the United States the per capita income is estimated frequently for the different parts of the country, and this can be taken as a measure of wealth, making the crude, and probably false, assumption that wealth is proportional to current income. Multiplying by the number of people in each area yields an estimate of the total money extant in each region. These numbers can be observed to change with time. The changes can be due to a change in the number of people, or in the « wealth ». The latter may be due to inflation, due to the creation or destruction of wealth, or due to the movement of wealth in to, or out of, the region. Only the movement is of cartographic interest, and we would like to be able to estimate this movement pattern. The difficulty of doing this from the observed changes only can be illustrated by the following simplified table, showing varying amounts of wealth in four regions at two time periods. Has any wealth moved ? A normalized version of the table is as follows :

region	time 1	time 2
A	40	35
B	20	35
C	30	10
D	10	20
totals	100	100

Clearly regions A and C have lost relative to regions B and D. The relative percentage losses are

A	-5
B	+15
C	-20
D	+10
sum	= 0

As a geographic problem we now need to estimate how five units can leave place A, and twenty units place C,

1. Estimated 1970/1976 wealth potential, Q(x,y), obtained as the solution to Poisson's equation indicated by contour lines, and with the gradient shown as a vector field. See text.

Potentiel de la richesse estimée (1970-1976), Q(x,y), comme solution à l'équation de Poisson, représenté par les courbes de niveau, le gradient étant un champ vectoriel.

to be moved at places B and D, in order to make the totals come out right. The two source regions A and C and the two destination regions, or sinks, B and D, are located in geographic space so that we can assume that one of the many available geographical flow models applies to this case.

In a more realistic situation, we have per capita income and population for the 48 contiguous states of the United States, in both 1970 and 1976 ; as given above we find that some states are losing wealth and others gaining. By dividing by the area of each state we obtain the source-sink density field, r(x,y), in dollars per square kilometer. The movement is now modelled by assuming that the system is reasonably efficient and therefore satisfies Poisson's partial differential equation,

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

potential function. The simplest boundary condition occurs when the system is closed, and thus that there is no external (i.e. international) movement of wealth.

For the detailed computations the contiguous area of the United States is approximated, somewhat crudely, by a 61 by 95 mesh, and the resulting system of 5795 finite difference equations solved by a relaxation technique, see Birkoff 1972. The resulting potential is shown in the form of contours in Figure one, and may be interpreted as an empirical estimate of the rate of return on investments. The gradient arrows can be connected to obtain the streakline pattern of Figure two, illustrating the calculated movement pattern. By superimposing (in the computer) the boundaries of the individual states on these maps, and by calculating the flux across each of these borders, we

2. Estimated trajectories of the flow of wealth computed from the potential field of Figure one.
Trajectoires estimées du flux de richesses calculées à partir du champ potentiel de la figure 1.

can obtain a table of estimated interstate transfers of wealth. This is illustrated graphically by the computer rendering in Figure three.

The pattern of geographic movement depicted is not surprising, given our current knowledge of demographic changes in the United States. The obvious notion is that people are taking their wealth with them, even in the present narrow equivalencing of per capita income as wealth. Or that they are moving towards where it exists, for these maps greatly resemble maps of the net population movement in the United States (compare with maps in Tobler 1981). The maps which are presented are of course very crude, with a mean resolution of circa 400 km, but they do seem to depict actual changes taking place in the United States, and, as such, are of some interest.

References

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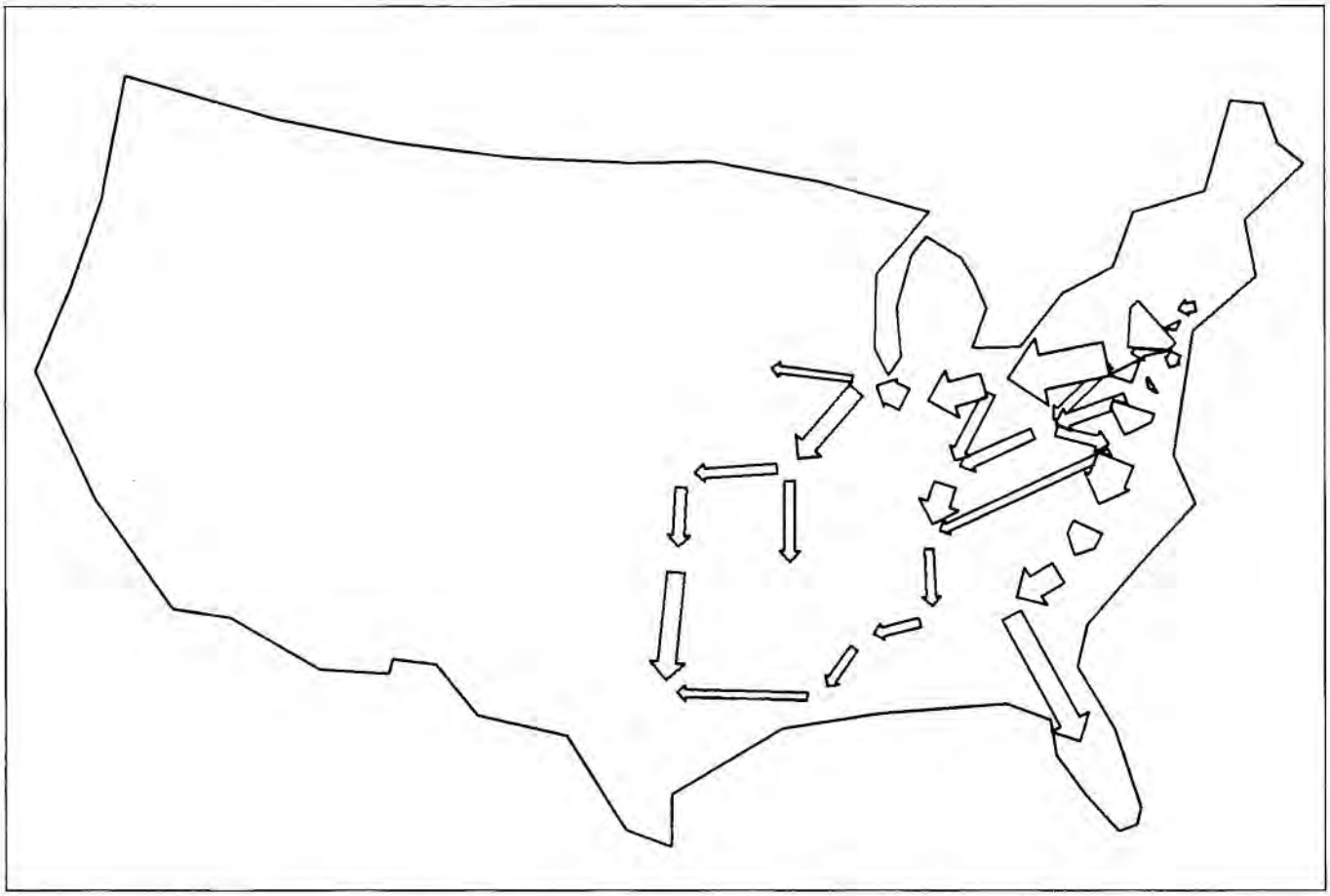

3. Interstate flow of wealth obtained by aggregation of the movement shown in the previous figures. Values below the average deleted for map clarity.

Flux de richesses obtenu par agrégation du mouvement décrit dans les deux figures précédentes. Les valeurs en-dessous de la moyenne sont négligées par souci de clarté.