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The impact of flood hazards on local employment

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In a spatial model of aggregate municipal employment, this article shows statistically that floods disrupt employment in municipalities. Flood events decrease local employment on average by 3.4%. Employment levels, however, recover after one year.

I. Introduction

Theoretical and empirical analysis of regional growth is rich and comprehensive. For example, Jacobs (1969) and Glaeser *et al.* (1992) show the effects of industry structure on innovation and economic growth. Observed regional productivity gains are associated with geographical concentration of industry and the effects of concentration on regional earnings are different across economic sectors (Bureau of Economic Analysis, BEA).[1] Industry productivity and employment also may be affected by natural hazards. The severity and nature of impact of a disaster depend on a range of factors. These include the type of hazard, the size of the economy and the sectors affected by the disaster. For example, droughts do not damage buildings or physical structures, but sudden-onset disasters such as floods or earthquakes have a direct impact on infrastructure and productive facilities and resources.

This article directly estimates the effect of flood events on local economic activity. Yet, rather than examining an extraordinary flood disaster such as Katrina, which paralyzed New Orleans for several months, we examine the impact of all flood events during a 2-year period across the USA. This provides a broader picture of the reaction of local economies to flooding. Different from previous work that models community employment, we thus include both structural characteristics (e.g. population) and unexpected events (e.g. floods).

In terms of methodology, we show the statistical and economic significance of the community location relative to others in explaining employment. The statistical analysis underscores spatial links of local employment through earnings offered per worker and shows that local economies vie for employment.

II. Total Employment

Economic region and geographical coordinates of counties across the United States explain spatial patterns of employment levels. Employment depends on population density and education in the municipality. Property taxes directly impact employment by contributing to operating expenses and local debt levels foreshadow future local taxes (Holcombe *et al.*, 1981). By economic theory, employment is directly correlated to earnings per worker.

The main economic sector in the municipality also is likely to explain spatial patterns in employment. Manufacturing, for example, fosters solid supply-and-demand growth, providing the base for durable economic growth for the wider economy. Yet, the share of the manufacturing sector in the US economy is shrinking in relation to the service sector. The service sector comprises both highly qualified as well as nonqualified labour.

To formulate an econometric specification of municipal employment, we model employment E_j in

[1] Early work by Carlino (1978), documents location choice in the manufacturing industry.

region j in terms of regional comparative advantages $\mathbf{C}_j$, the economic and financial characteristics of the municipality $\mathbf{X}_j$ and local earnings per worker ER_j. Employment may also depend on disruptions to the local economy from floods $\mathbf{F}$. Floods are the most frequent and expensive natural disaster in the United States. Ninety percent of all natural disasters in the United States involve flooding (*Insurance Information Institute, March 2005*).

Mathematically, the statistical model of employment at municipality j is:

$$\ln E_j = a + d \ln ER_j + \mathbf{C}_j\beta_1 + \mathbf{X}_j\beta_2 + \mathbf{F}_j\beta_3 + \xi_j$$

where, employment E_j at region j depends on $\mathbf{C}_j$ and $\mathbf{X}_j$, as well as local earnings per worker ER_j. The vector $\mathbf{X}_j$ comprises population P_j and the level of urbanization in the county U_j. This vector also includes municipal taxes T_j, debt D_j and local population with a college education, CE_j. The vector $\mathbf{C}_j$ comprises codes of the county with respect to the main economic sector. We code whether the main sector is farming H_j, manufacturing M_j, or services S_j, respectively. The vector $\mathbf{C}_j$ also comprises geographical endowments captured by the county's geographical latitude L_{1j} and longitude L_{2j} (Sarmiento, 2004). The vector $\mathbf{F}_j$ contains codes of floods that cause residential damage during the year of the flood, F_j, or the previous year, F_{j-1}. The econometric residual, ξ_j, captures other factors not captured in the model.

In addition to the characteristics of the county, we include community distance and earnings per worker relative to others in explaining employment. A spatial lagged explanatory variable on sector earnings per worker, $ER_{sp,-j}$, in particular, arises in explaining employment at region j:

$$\ln ER_{-j,p} = \sum_{k \neq j} \ln ER_{kp} \exp(-\mathrm{Dist}_j k/\gamma)$$

where, Dist_{jk} is the distance between communities j and k (Sarmiento and Wilson, 2005). Employment, at region j, with spatial correlation is:

$$\ln E_j = a + d \ln ER_j + \mathbf{C}_j\beta_1 + \mathbf{X}_j\beta_2 + \mathbf{F}_j\beta_3 + \rho_1 \ln ER_{-j,n} + \xi_j \qquad (1)$$

where, in the implementation of the estimator, the residual sum of squares of the errors can be concentrated in terms of the scale parameter γ of the index of sector earnings by nearby communities. If $\rho_1 < 0$, then employment decreases with earnings per worker offered in neighbouring locations. Furthermore, if $\gamma > 0$, then the size of the impact tempers down with the geographical distance between the municipalities. Estimates of Equation 1 yield insights into the actual operation of local economies and the consequences of natural hazards on local employment.

III. Data and Estimation

To estimate the factors that determine employment at the municipal level, we use data on employment for 1997 and 1999 reported in the *US Bureau of Economic Analysis*. For the sample of communities, we used data from all 1200 municipalities with local government finance data (e.g. local taxes and municipal debt) reported in the *Statistical Abstract of the United States* 2002 (CD-ROM). Data on municipal population, economic typology and population with college degree was extracted from the *US Census*. From this source, we also obtain a *US Census* urbanization indicator by municipality. Small values of the urbanization index indicate large metropolitan areas, whereas high numbers code rural areas (low urbanization).[2] BEA regions are extracted from the *Department of Commerce*.

Indicators of flood events in each municipality are extracted from the *National Weather Service* (NWS). The NWS annually reports communities suffering economic losses from floods and storms. Floods that impacted residences in the community were identified and indexed as a dummy variable. Only qualitative information indicating that flood damages occurred (significant flood) could be coded because reported damages are aggregated across all municipalities with damages in a flood event.

To estimate Model 1, we concentrate the residual sum of squares with respect to the scale parameter γ of the spatial lag (Sarmiento and Wilson, 2005, 2006). To include heterogeneity, the nonlinear least squares estimator incorporates both fixed and random effects with respect to each county's BEA region. Elasticity estimates derived from the concentrated weighted least squares estimator of Equation 1 are reported in Table 1. Estimation results in the table show the effects of regional variables on total employment.

[2] The urbanization indicator ranks municipalities with respect to urbanization in categories. The first category, for example, includes municipalities located in metropolitan areas with populations of one million or more; a mid-range urban area in the ranking has an urban population of 20 000 or more, but not adjacent to a metropolitan area; and the category for least urbanization is a completely rural or less than 2500 urban population, not adjacent to a metropolitan area.

IV. Results

Controlling for other factors, Table 1 shows that floods negatively explain employment at the 95% confidence level. Flood events decrease local employment by an average of 3.4%. For example, under the average unemployment rate of 5 %, flood events that damage property increase local unemployment to 8.2%. Analysis of lagged effect, however, shows that the effect of floods on employment does not persist beyond one year. Losses of economic activity are thus concentrated in the year of the flood and the level of employment seems to recover one year after the flood. Employment losses caused by the flood in the year of the flood, however, constitute a permanent loss in expected accumulated wealth levels at both the individual and community level. This loss of wealth may have significant impact on the communities' welfare.

As expected, Table 1 shows that employment increases with the population of the municipality and, consistent with economic theory, employment is larger in those areas with larger earnings per worker. Larger concentration of employment occurs in regional economies where the main sector is services and total employment is larger in areas with a larger concentration of human capital (more population with college degrees). Interestingly, employment per capita (after filtering out population) is larger in more urbanized counties.

Public finance theory suggests that an increase in local taxes will decrease earnings in the jurisdiction. The main source of revenues for local government is local taxes. Table 1 confirms that employment is lower when local taxes are higher, but the effect is not statistically significant at the 95% confidence level. Total debt in the municipality, in contrast, has a statistical significant negative association with total employment. Higher local government debt apparently is associated with lower resources in the local economy that can be used to generate employment.

In addition to the characteristics of the county, we include the geographical distance to the neighbouring municipalities and their earnings per worker. Neighbouring municipality earnings per worker, in particular, help to explain local employment. Earnings per worker in the neighbouring communities are inversely related to the community employment levels at the 95% confidence level. Local economies thus vie for employment based on local earnings per worker.

V. Conclusion

This article pinpointed the effects of flood events on local economic activity. We showed statistically that, the floods disrupt employment in municipalities affected by floods. Flood events the decrease employment of the affected municipalities, in average by 3.4%. Employment levels, however, recover after 1 year. Unemployment benefits presumably will increase as employment falls. Disruption of employment implies loss of wealth to affected

Table 1. Coefficient estimates of the local-employment model

Variable	Coefficient estimates	*t*-value
Constant	−1.995	−10.723
Lat – Latitude	0.003	2.674
Long – Longitude	0.002	2.825
Time fixed effects	0.041	7.303
R_j – Gov. local revenue	−0.001	−0.205
D_j – Gov. Debt	−0.004	−3.292
P_j – Population	0.901	67.959
E_j – Education	0.070	6.160
U_j – Urbanization Index	−0.032	−10.255
H_j – Code farm	0.007	0.365
M_j – Code manufacturing	−0.008	−1.170
S_j – Code services	0.050	5.834
F_j – Flooded this year	−0.034	−3.595
F_{j-1} – Flooded last year	−0.001	−0.210
ER_j – Earnings	0.616	72.294
$ER_{-j,n}$ – Spat. lag earnings	−0.002	−3.350

Note: F_j and F_{j-1} capture dummy variables for flood-related events that caused damages to residences in the current year and the previous year. Small values of the urbanization index indicate large metropolitan areas, whereas high numbers code rural areas (low urbanization).

residences and businesses. The statistical analysis underscores spatial links of local employment through earnings offered per worker.

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