Adjustment Costs from Environmental Change: Data Appendix

David L. Kelly
Department of Economics
University of Miami
Box 248126
Coral Gables, FL 33134
dkelly@miami.edu

Charles D. Kolstad
Department of Economics,
Bren School of Environmental Science and Management,
University of California
Santa Barbara, CA 93106
and University Fellow, Resources for the Future
kolstad@econ.ucsb.edu
805-893-2108
805-893-8830 (fax)

and

Glenn T. Mitchell
Economic Analysis Corporation
Los Angeles, CA 90067

Running Title: Adjustment Costs from Environmental Change

October 4, 2004

8 Data

We use annual county observations for the US, 1975-97. Estimation is based on 1976-1997 because of the lagged variables. The statistics cover 512 counties over 21 years, for a sample size of 10,752. Table I in the body of the main paper summarizes the statistical properties of the variables used.

We restrict attention to a 5-state region of the US (Illinois, Iowa, Kansas, Missouri and Nebraska). Although the data are available for the entire US, we have found that agriculture is so varied that it is difficult to estimate a single technology of production for the entire US (Schlenker et al. [6] find a similar result and argue that differences in irrigation requirements are an important reason). Additionally, returns to some specialized crops that can only be grown in particular areas are very high relative to other agricultural products; this tends to obscure relationships for agriculture in general. We sought a compact, contiguous region with similarities in agriculture. We settled on the following criteria in selecting states: the majority of land is agricultural; the majority of agricultural land is cropland; and each state in the sample is contiguous to at least two other states in the sample. This results in the five state region mentioned above. The area and agricultural revenue are comparable to a moderately sized developed country (such as France, for example). The variety and composition of crop output is very similar to the United States as a whole, with the exception of some specialty crops such as grapes and citrus fruits for which the Midwest has little output. Although climate and geography vary less across the region than the entire country, the climate change scenario in the next section is well within the range of climates in the data (only one is greater than two standard deviations from the mean in the data, see Table 1). None of the states border the ocean or the Great Lakes (with the exception of a small portion of Illinois), nor do they contain significant mountain ranges (all of which influence the accuracy of weather observations). States to the north of have colder weather and significantly more dairy production. To the West are Rocky Mountain states, and to the East are the Appalachian mountains. States do tend to be warmer and more mountainous to the south, much dryer to the southwest and much wetter to the southeast.

8.1 Profits

The endogenous variable in the estimation is profits per acre of land, or more specifically, quasi-rents accruing to land. The data are farm income per acre of agricultural land from the Regional Economic Information System of the US Department of Commerce, Bureau of Economic Analysis (BEA) [7] and are computed as farm revenue less variable production costs. The BEA revenue and cost data are annual, but are prepared using the Agricultural Census (taken every 5 years), and the "best available county data" during non-census years. Thus the data is annual, but data sources differ by year. Revenues include most Federal subsidies. Our definition of profits as quasi-rents should exclude land rentals. Land rental payments are both a revenue and expense in this data, and are thus excluded as long as the income and expense are in the same county. A final simplification is that we effectively assume owner's labor income is zero for sole proprietorships, by measuring quasi-rents as equal to profits in the case of sole proprietorships. Profits are converted to 1990-1992 dollars using the CPI provided by the Bureau of Labor Statistics [1].

8.2 Prices

The U.S. Department of Agriculture has a monthly index of various agriculture prices spanning the years 1975-1997 [10]. Each index represents a specific category of agricultural products (such as "dairy products") or agricultural inputs (such as "fertilizer") for which the prices of particular products are expected to move in a similar fashion. The average of 1990-1992 prices is the base, equal to 100. We use the December value for each year. Six of the output indices cover over 95%

of all the outputs in the area of study. Feed grain and food grain are closely correlated and thus combined into a single index (weighted by the relative levels of output). The result is five output price indices: meat, grain (feed grain and food grain), oil crops, dairy, and poultry. These output prices do not vary by county.

Although USDA input price indices do not vary by county, the use of inputs does vary by county. Thus an aggregate input price index is constructed for each county, based on the relative weights of various inputs in each county. Additionally, this aggregate input price index is used as the numeraire (the denominator in all of the quadratic terms). This creates a potentially unique vector of prices for each county.

8.3 Weather

Weather for a county is constructed from weather station information [3], following approximately the method of Mendelsohn et al. [2]. The weather data used for estimation are weighted averages of all weather stations within 500 miles of the center of the county (weighted by the inverse of the distance). The conversion factor used for distance (both to generate weather estimates and for the autocorrelation correction) was 90 miles per degree, which is approximately correct in the center of the United States. The meteorological station data is from the U.S. Historical Climatology Network Serial Temperature and Precipitation Data [4], available electronically at ftp.ncdc.noaa.gov/pub/data/ushcn. Some rainfall data are erroneously negative in primary data set; we have not changed the primary data. Changing negative values affects only negative reporting errors, thus making observation errors not mean zero and not normal, two assumptions we have made. It is also not clear if negative values are in reality observations of zero or for example positive two inches when negative two inches were recorded. The county centroid longitude and latitude are from the National Weather Service Shapefile Catalog [5], drawn form USGS data (USGS

1:2,000,000 DLG), available electronically at ftp.nws.noaa.gov/modernize/shapemap/county.

Weather is normalized by subtracting the mean of a particular weather variable from the realization of that variable and dividing the difference by the standard error of the variable. Our hypothesis is that the difference between realized weather and mean weather (climate) has an effect on profits separate from climate since one can adjust input decisions in response to climate but not in response to weather. Further, we standardize by dividing by the standard error because our hypothesis is that weather five degree above normal has a bigger effect on profits when normal variation is one degree than when normal variation is five degrees. The weather data that we use are monthly precipitation, precipitation squared, monthly average temperature, and average temperature squared for January, April, July, and October.

8.4 Climate

For climate, we use most of the first and second moments of the weather for each of the four months assuming weather in one month is independent of weather in another month. These are computed using data from 1930 through the year prior to the year in question. Thus for each month we use a mean precipitation and temperature, a standard error and a covariance between the precipitation and temperature, for a total of twenty climate variables. We ignore uncertainty associated with the estimates of the first and second moments. This is a slight oversimplification which should lead to no significant inaccuracies.

8.5 Land Characteristics

We assume soil characteristics are unvarying over the sample period. The soil variables are county-wide estimates that were generated from the 1982 National Resource Inventory soils database, and are supplied by ZIPFIP from the USDA Economic Research Service [9]. The elevation data also comes for the National Resource Inventory, as supplied by ZIPFIP from [9], available electronically at ftp.mannlib.cornell.edu/data-sets/general/93015. Time is also included to capture neutral technical change.

8.6 Demographics

County demographic information is included as a fixed factor for two reasons. First, the composition of population and income in a county may affect the availability and quality of capital and labor, and so directly affect the production technology for agriculture. Second, the soil variables described above represent an average across an entire county. Land in a county is used for a variety of purposes other than agriculture. As land gets transferred from agriculture use to other uses, this alters the quality of the land remaining in agriculture. Income and population affect how much land is used for purposes other than agriculture, and therefore affect the accuracy of the soil characteristics. The observations are interpolated values, using decennial census data and interim surveys, constructed at the county level by the U.S. Census Bureau, and supplied by the Regional Economic Information System [8].

References

[1] Bureau of Labor Statistics: 1997, 'Consumer Price Index - Seasonally Adjusted'. Technical report, BLS Data Series CUSR0000SA0, Washington, DC.

[2] Mendelsohn, R., W. D. Nordhaus, and D. Shaw: 1994, 'The Impact of Global Warming on Agriculture: A Ricardian Analysis'. *American Economic Review* **84**(4), 753–71.

[3] Mitchell, G. T.: 2000, 'Technology, Energy and the Environment'. Ph.D. thesis, Department of Economics, University of California, Santa Barbara.

[4] National Oceanic and Atmospheric Admin., National Climatic Data Center: 1996, *U.S. historical climatology network serial temperature and precipitation data*. NOAA-NCDC, Asheville, NC.

[5] National Oceanic and Atmospheric Admin., National Weather Service: 1997, *U.S. Shapefile Catalog*. NOAA-NWS, Silver Spring, MD.

[6] Schlenker, W., W. M. Hanemann, and A. C. Fisher: 2004, 'The Impact of Global Warming on US Agriculture: An Econometric Analysis'. *Review of Economics and Statistics* **forthcoming**.

[7] US Dept. of Commerce: 2001, 'National Income and Product Accounts of the US'. Technical report, BEA Report.

[8] US. Dept. of Commerce, Bureau of Economic Analysis: 1997, *Personal income, total population and per capita income by county and metropolitan area*. US. Dept. of Commerce, Washington, DC.

[9] USDA Economic Research Service: 1992, *Climate and soil data*. via ZIPFIP, USDA-ERS, Herndon, VA.

[10] USDA Economic Research Service: 1996, *Costs of production: U.S. corn production costs*. via ZIPFIP, USDA-ERS, Herndon, VA.