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Hyper-extractive counties in the U.S.: A coupled-systems approach

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A B S T R A C T

In this paper, we advance a theoretical framework for defining hyper-extractive coupled-systems in the United States. Our purpose is to extend a model constructed for an agricultural system in Southwest Kansas into a general theory that can be used to successfully classify counties across the U.S. that depend on the extraction of natural resources. We begin with developing the theoretical foundations for the hyper-extractive coupled-system. We then fit this theory within the existing literature regarding the classification of rural counties. Finally, drawing on a coupled human–natural systems theoretical framework (Liu et al., 2007), we develop a new spatially based empirical measure of rural context that captures the complex, multidimensional interactions between humans and their natural environments. GIS hot spot and factor analytic techniques are used to empirically identify existing coupled-systems, linking contiguous counties in the rural U.S. based on 35 indicators of land use, employment patterns, demographics, physiography, and climate. In addition to identifying three different types of hyper-extractive counties across the U.S., our approach reveals a number of other coupled-systems based on agriculture and ranching, mining, manufacturing, scenic amenities, and forestry and fishing.

Introduction

Coupled human–natural systems exist all over the world wherever humans interact with their environment. Although all these interactions are significant, some are clearly more important than others on the basis of the type and scale of human actions and the ecosystem being affected by these human actions (Liu et al., 2007). Thus is the case for the High Plains (Ogallala) Aquifer. The entire aquifer spans 450,000 km^2 and comprises 27% of the irrigated land in the United States (Dennehy, 2000, 6). Despite the High Plain's arid environment, irrigation from the aquifer enables farmers to plant water intensive crops like corn, soybeans, cotton, and alfalfa (Custodio, 2002). In turn, value-added agricultural industries, including confined feeding operations for cattle and hogs, dairy, ethanol plants, and meat-processing facilities have sprung up in the region to take advantage of the abundance of irrigated feed grains and finished live animals. Nowhere in the High Plains is this more true than in Southwest Kansas, where large scale confined feedlots provide finished cattle for several of the world's largest meatpacking factories (Broadway & Stull, 2006).

These local economies may be seen as examples of successfully overcoming the economic and demographic challenges that rural places have been facing since the 1970s, resulting in population growth in these counties whereas the norm for most rural counties is population stagnation or decline. However, the one-dimensional vertical concentration of industries based on the extraction of a non-renewable natural resource makes such systems vulnerable. We refer to this pattern of development as a "hyper-extractive" coupled-system, given the basis of this economic structure and the unique social and demographic characteristics triggered by it.

In this paper, we advance a theoretical framework for defining hyper-extractive coupled-systems in the United States. Our purpose is to extend the archetypal example hyper-extractive coupled-system in Southwest Kansas into a general theory that can be used to classify counties across the U.S. We begin with developing the theoretical foundations for the hyper-extractive coupled-system. We then fit this theory within the existing literature regarding the classification of rural counties. Finally, drawing on a coupled human–natural systems theoretical framework (Liu et al., 2007), we develop a new spatially based empirical measure of rural context that captures the complex, multidimensional interactions

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between humans and their natural environments. GIS hot spot and factor analytic techniques are used to empirically identify existing coupled-systems, linking contiguous counties in the rural U.S. based on 35 indicators of land use, employment patterns, demographics, physiography, and climate. In addition to identifying hyper-extractive counties across the U.S., our approach reveals a number of other coupled-systems based on agriculture, mining, manufacturing, scenic amenities, and forestry and fishing.

Theoretical framework for hyper-extractive coupled-systems

Four major conceptual themes serve as the basis for the theory of hyper-extraction coupled-systems: (1) boomtown development; (2) path dependence; (3) extractive-based rural economies; and (4) regional economic clusters.

The boomtown literature (Black, McKinnish, & Sanders, 2005; Brown, Dorius, & Krannich, 2005; Malamud, 1984; Smith, Krannich, & Hunter, 2001) argues that boomtowns develop and prosper almost overnight, largely based on making a profit from the extraction of resources (mostly mining operations) from the land. Their rapid growth, often doubling a town's population in 5 years or less, and subsequent busts are legendary (Smith et al., 2001). The social and environmental externalities of boomtowns are grave, leading to higher crime rates, prostitution, gambling, divorce, and alcohol abuse, and often, environmental catastrophes that still haunt these rural landscapes.

Many of the communities settled over the High Plains aquifer went through extended periods of growth starting in the 1950s with the introduction of irrigation technologies, followed by an additional burst of population growth in the late 1970s through the 1990s with the expansion of the meatpacking industry. Thus, even though the boomtown literature is relevant, it is most applicable to communities with accelerated growth and bust cycles versus High Plains agriculture communities like those in Southwest Kansas, which have taken longer to develop and in many cases have yet to bust.

The theoretical framework for "path dependence" also strongly influences the model of a hyper-extractive coupled-system. Path dependence, a concept first identified by economists (Arthur, 1989; David, 1985) is present if agent actions at one point in time affect the choices available to future agents. For many extractive agricultural regions, labor-saving technology or programs favoring absentee ownership lead to out-migration of workers, thus reducing demand for retail outlets, food services, etc. As those industries shrink, the labor pool becomes still smaller, with an aging population, and even more specialization (Johnson and Rathge, 2006).

The literature on extractive rural economies reinforces this version of the path dependence model (Adamchak, Bloomquist, Bausman, & Qureshi, 1999; Albrecht, 1993; Flora, Flora, Spears, & Swanson, 1992; Funk & Bailey, 2000; Kraenzel, 1955). This literature emphasizes that the socio-economic basis of many rural areas are extractive rural economies, based either the harvest of a renewable resource or the mining of a non-renewable mineral deposits. The common theme uniting these extraction-based communities is that a large majority of them are in decline, losing jobs and population. These factors combined together reduce the marginal return on each unit of production, encouraging producers to seek greater economies of scale and increased production via mechanization, energy consumption, and larger scale operations with fewer employees. Once this form of path dependence begins, it is both vicious and long-term.

On the other hand, the literature on "regional economic clusters" (Drabenstott, 2003; Drabenstott & Sheaff, 2002; Drabenstott, Henderson, Novack, & Abraham, 2004; Katz, 2000; McDaniel, 2003; Winkler, 2010) suggests a different type of path dependence for some rural extraction-based systems, one based on the expansion of an industry or set of related industries in a county or region. The basic idea is rather straightforward in both principle and practice. An economic cluster focused on one type of product or service (e.g. aircraft, computers, meatpacking, plastics, optics, recreation or wine) in a region creates external economies of scale for producers, suppliers, financial institutions, manufacturers, and/or related service providers associated with the economic cluster. These economic clusters are also able to more easily attract skilled, semi-skilled, and unskilled labor forces necessary to make the economic cluster productive and competitive. In the value-added agricultural clusters, the labor force has a strong immigrant flavor, particularly from Mexico and other Central American countries (Broadway & Stull, 2006). For both types of path dependencies, growth or decline, the nature of the decisions made in the past impedes any specialized region wishing to "reinvent themselves" by attracting new industries (Martin & Sunley, 2006).

A dependence on the mining of the common pool resource of fresh water is a prominent component of some extractive agricultural economic clusters (Hardin, 1968; Kromm & White, 1992; Opie, 1993). Aquifers, like the High Plains Aquifer, are classified as a common pool resource because the action of one irrigator – either efficiently or inefficiently using water from the aquifer – has little impact on the condition of the aquifer as a whole. Thus, there is little incentive for one irrigator to substantially alter his/her behavior regarding the use of this common pool resource (Ostrom, 1990). Often, this leads to abuses to the common pool resource as each individual acts to maximize his/her use of the resource. This condition has led to issues of sustainability (Kromm & White, 1992; Opie, 1993) and environmental boundedness as captured by the work of Deborah and Frank Popper (1987, 1999). The Poppers, who focus their research on the High Plains Aquifer, note that the area's arid environment can only sustain certain types of land uses in the long-term. Development patterns that exceed the capacity of the land and water resource to sustain it or development patterns that cannot afford to import the necessary resources to sustain production are doomed to failure.

While in many cases the abuse of a common pool resource is exemplified in land-use patterns, this is not always the case. For years, the issue of how to regulate the common pool resource of both inland and coastal marine fisheries to prevent to over-harvesting of a variety of fish stocks has maintained a prominent place in the common pool research literature (Dietz, Ostrom, & Stern, 2003; Schlager, 1994; Ostrom, Gardner, & Walker, 1994). As this literature shows, hyper-extractive coupled-systems can take a variety of forms.

Hyper-extractive coupled-systems represent one of the more complex interactions between human and natural systems. The setting of these systems is buried within classic rural extractive-based (agriculture, forestry, fishing or mining) systems. Even though negative population change, out-migration and aging cohorts are the most common forms of path dependence among these rural counties; hyper-extractive coupled-systems have found a means to develop their extractive-based economies to overcome this rural decline path dependence. Thus, hyper-extractive coupled-systems are rural in character, dependent on the extraction of natural resources at a rate that is above the norm, and have a recent history of population growth and in-migration, which may have an Hispanic/Latino ethnic emphasis. With these system markers, we analyze hyper-extractive coupled-systems among rural counties in the U.S. Based on the boomtown literature, we expect these hyper-extractive coupled-systems will suffer from social externalities.

A wide variety of social-demographic, employment, natural resource, and environmental factors define hyper-extractive coupled-systems. Identifying hyper-extractive counties across the U.S. requires a research design that takes full advantage of all these types of variables. Dichotomous classifications, such as farming or