

# Recent Economic and Community Impact of Unconventional Oil and Gas Exploration and Production on South Texas Counties in the Eagle Ford Shale Area

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**Abstract.** Unconventional oil and gas extraction efforts have raised the specter of the resource curse in affected communities, as has been demonstrated in other industries or geographies. Yet because these developments in unconventional extraction industries are so new, data for analysis is limited. This study examines recent activity in the Eagle Ford Shale area of South Texas with a time-series cross-sectional (TSCS) approach using data collected from 14 actively producing counties over a four year period from 2008-2011. Results indicate that the number of completed oil and gas wells has had a positive impact on per-capita income to-date. Previous research suggests that communities in South Texas have the opportunity to overcome the resource curse, but that it will require good local governance and thoughtful long-term planning.

## 1. Introduction

Recent unconventional oil and gas exploration in the United States has produced unexpected benefits in the balance of trade and global energy security. The impacts are also being felt at the community level in several parts of the U.S. One such area is the Eagle Ford Shale in South Texas, which has historically been among the poorest areas in the state.

The Eagle Ford is a unique formation; whereas most shale oil and gas fields are predominantly either oil or gas, Eagle Ford contains significant quantities of oil, gas, and condensate. As such, the recent boom in energy production presents an interesting case study about how local communities are addressing the opportunities and challenges. This study will take a very preliminary look at the shale oil and gas field in the Eagle Ford in South Texas in order to assess the prospect of the resource curse in the early stages of development.

## 2. Theoretical framework

The relatively recent development of unconventional oil and gas fields in the United States has prompted research on economic impacts. Extant literature suggests that recent shale oil and gas exploration, while limited, can be examined in the context of the resource curse theoretical framework. Much research has been performed at the international level on the curse of natural resources, which proposes that resource-abundant countries have stagnated in terms of economic growth (Sachs and Warner, 1995, 2001). Other studies have focused on within-country impacts of resource abundance (Michaels, 2010; Weber, 2012). Whether researchers look across or within countries, it is difficult to find a clear validation of the resource curse theory (Brunnschweiler and Bulte, 2006; Torvik, 2009; Michaels, 2010; James and Aadland, 2011). The resource curse is cited frequently in the literature,

which suggests that there is an inverse correlation between natural resource abundance and long-term economic growth (Mikesell, 1997). Yet the tendency for slower growth effects is not uniform across nations, states, or even counties, where the least amount of research has been done (Peach and Starbuck, 2011). While a significant number of the cases examined in the literature show some kind of negative impacts regarding the resource curse, there are enough successes to suggest that factors other than mineral resource abundance alone are at work.

There is often a divide between economic development theory and practice. Further, despite a regional emphasis in the literature, development in the real world tends to be highly subject to more localized political boundaries (Currid-Halkett and Stolarick, 2011). The approach in this article will be to attempt to shed light on economic development and the resource curse by analyzing the applicable data that are available at the local level for the 14 counties most actively producing oil and gas in the Eagle Ford in South Texas.

The limited number of counties makes a combination of time-series and cross-sectional analysis attractive from the standpoint of number of observa-

tions and corresponding degrees of freedom. Four years of data from 2008-2011 for 14 counties yields 56 total observations. Even though the sample is limited, it is important to note that significant variation can exist between ostensibly similar local government entities, not an unusual situation (Reese and Rosenfeld, 2001). In addition to the publicly available data analyzed in a quantitative fashion, it was possible to gather information informally from a wide range of stakeholders in the Eagle Ford Shale production area, including county judges, economic development directors, city managers, and mayors. As such, a fairly robust portrait can be painted of economic development efforts to-date in the context of an emerging energy resource boom.

### 3. Background

#### 3.1. The counties of the Eagle Ford

Many of the counties in South Texas have been among the poorest in the state, if not the country. With the exceptions of McMullen, Wilson and DeWitt Counties, all of those in the study area ranked above the average rate for Texas, as can be seen in Figure 1.

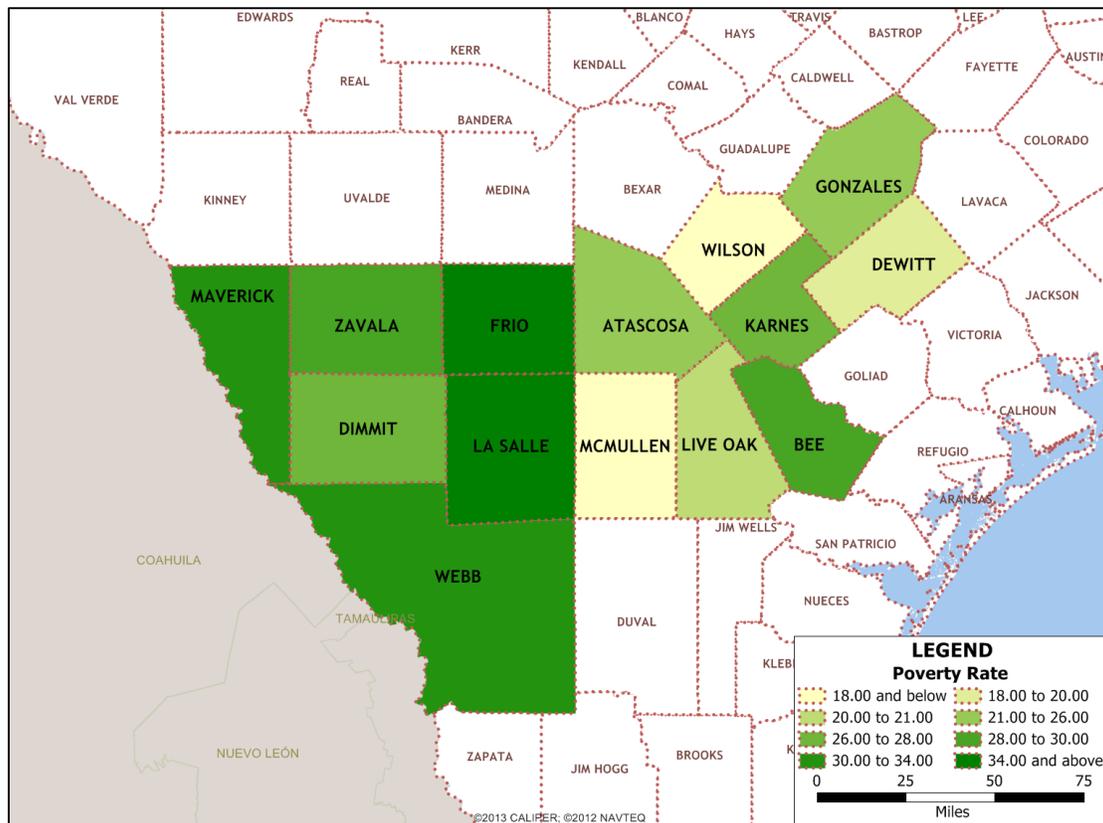


Figure 1. 2011 Poverty Rates in 14 Producing Counties in the Eagle Ford Shale. (Map courtesy of Hisham Eid.)

The special challenges that rural communities face include lower than average educational attainment. South Texas is no exception. High numbers of residents have less than a high school education, which translates into lower educational attainment overall. This in turn inhibits economic development in South Texas. Local higher educational institutions have developed programs to address many of the emerging needs of the oil and gas industry, which could also improve educational achievement over time along with prospects for the local workforce.

Prior to the ramp-up of activity in the Eagle Ford, population out-migration was also a significant issue in South Texas. For example, from the relatively recent period 2000-2010, six counties in the Eagle Ford area lost population (Bee -1.54%; Dimmit -2.46%; San Patricio -3.48%; Karnes -4.03%; Live Oak -6.32%; McMullen -16.92%). Further, across all of Texas during that period, 79 (all rural) counties had population declines.

### 3.2. Eagle Ford Shale

It is clear that the Eagle Ford Shale presents researchers with unique characteristics worthy of examination. While several peer-reviewed economic development studies have been conducted on hydraulic fracturing for natural gas to date (Blumsack, 2011; Christopherson and Rightor, 2011; Considine, Watson, and Blumsack, 2011; Kinnaman, 2011; Weber, 2011), far fewer (if any) have been conducted on unconventional *oil* plays. Usually shale fields contain predominantly one or the other resource – either natural gas or oil. By comparison, the Eagle Ford Shale formation contains significant quantities of natural gas, crude oil, and a related substance known as condensate, which is a natural gas liquid. Condensate resembles petroleum in appearance, is lighter than West Texas Intermediate or Brent crude oil, and is measured in barrels, not cubic feet as is natural gas.

While shale deposits can be found all over the world, the U.S. is the only country where any significant production is occurring. Other countries, such as China, Ukraine, Argentina, and Mexico, are looking to tap into their own shale oil and gas reserves, but that prospect appears to be at least a few years away.

Active gas shale fields in the U.S. include the Marcellus formation located in Pennsylvania, New York, Ohio, and West Virginia, the Haynesville formation in East Texas and Northern Louisiana, and the Barnett formation in and around Fort Worth,

Texas. The Bakken formation in North Dakota, by contrast, produces mostly oil - nearly 900,000 barrels per day in 2013. Various formations in West Texas, the Utica in Ohio, and the Niobrara in Colorado, Nebraska, and Wyoming hold the potential for mostly oil production as well.

Texas is also somewhat unique relative to other states in that it benefits from all phases of oil and gas production: upstream, midstream, and downstream. As a result, communities like those in the Eagle Ford have opportunities to participate in economic activity along the entire supply chain. Estimates of economic impact for the 14-county area in 2011 were \$10.8 billion in gross regional product (Tunstall, Oyakawa, et al., 2012) and had more than doubled to \$22.9 billion in gross regional product by 2012 (Tunstall, Oyakawa, et al., 2013).

Daily oil production in the Eagle Ford has reached over 800,000 barrels per day, natural gas production runs at about 3.5 billion cubic feet per day, and condensate production is just under 200,000 barrels per day. The production of these three commodities has buffered South Texas from the significant price difference that exists between natural gas and oil. For example, when natural gas prices hit lows of \$2 per thousand cubic feet (mcf) in 2012 (down from \$8-\$12 mcf in previous years), the slowdown in activity that occurred in predominantly natural gas shale fields such as the Barnett and Haynesville did not occur in the Eagle Ford because oil prices remained relatively high (between \$77 and \$109 per barrel). Energy producers in the Eagle Ford simply shifted their drilling activity from natural gas to oil, and production activity continued unabated.

The Eagle Ford (as well as other shale fields in Texas) also benefits from the fact that job growth from oil and natural gas extraction tends to be concentrated in states like Texas where energy companies are headquartered. Such jobs include engineers, corporate managers, and consultants (Rumbach, 2001). Texas has a long history of oil and gas exploration, including regulation by the Railroad Commission and a system of established, well-defined mineral rights. These factors are more likely to offset resource curse effects. Further, other states or countries that have experienced the resource curse have typically simply exported natural resources with minimal downstream processing (Ross, 1999). Texas, by contrast, has more refineries than any other U.S. state and, as a result, generates many additional jobs beyond primary oil and gas extraction.

Nonetheless, community leaders in the Eagle Ford region face significant challenges, as some externalities have not been adequately addressed. These include road infrastructure, police and fire responders, and healthcare capacity. Despite the fact that city and county sales taxes and property tax collections are on the rise, they fall far short of the budget required to replace, repair, or upgrade all of these needs.

#### 4. Sustainable Community Development

Economic development can be an uneven process, and there is no guarantee that any given community will prosper over the long term. As an example, if we look back at the past 150 years or so, it might surprise us to learn that over 200 ghost towns have evolved in Texas. These towns typically had growing populations from the 1850s until the early 1900s and then saw a significant decline. Some have become completely abandoned. In several cases, a fall in demand for natural resources from a given geography was the proximate cause for the town population to dwindle, though other reasons include highway or railroad bypass, drought, relocation of county seats, creation of manmade lakes, or the widespread consolidation of agriculture that occurred from the 1930s to the 1970s due to mechanization (Baker, 2003).

Not so long ago, many communities in South Texas probably had concerns about becoming the next ghost town as well. But then, without warning, unconventional oil and gas exploration techniques changed the landscape entirely. The methods being employed to extract oil and gas from shale rock consist of the innovative use of two older technologies that date back approximately 65 years. By combining hydraulic fracturing with accurate horizontal drilling, these unconventional techniques, first pioneered in the Barnett Shale, are transforming energy markets. Largely as a result of these techniques, Texas produces more than it has in over 30 years. The U.S. produces more oil than it has since 1989, and imports from OPEC have been declining steadily for the past five years.

Now, local residents are faced with issues regarding sudden resource wealth. Yet, as Texans know probably better than anyone else, booms will sooner or later lead to slowdowns, if not outright busts. The Permian Basin area in West Texas, for example, which is heavily dependent on oil and gas production, has for decades seen ups and downs in its economy related to the price of crude oil.

With a wealth of such cautionary tales, many Eagle Ford Shale communities are working to ensure sustainability based on job creation in a variety of diversified industries, good quality of life, and stewardship of the environment, which are the defining components of current economic development theory (Portney, 2013). In addition, the literature suggests that communities should also employ other strategies that address high-quality physical infrastructure and workforce development (Osgood, Opp, and Bernotsky, 2012).

The situation in South Texas is rife with challenges as a result of the shale oil and gas boom. For example, there is clearly the potential for crowding-out effects to impact other industries. Restaurants and retail stores have reported difficulty hiring and now offer signing bonuses or have resorted to paying workers twice the minimum wage. School districts and city offices are losing employees to the energy industry. Housing is in short supply, rents have doubled or tripled, and most hotels are regularly sold out. Given these circumstances, it would be very unlikely for a company unrelated to the oil and gas industry (or its support) to consider locating in the area.

Some possible approaches to mitigating impacts from the resource curse have been proffered in the literature (Stevens, 2003). These include:

**Decreased Production Rates** – Essentially argues for undertaking slower development of natural resources. This gives the local economy and society more of an opportunity to adjust, which contrasts with the sudden surge that the Eagle Ford counties (and many others) have experienced. Under this scenario, revenue management for communities becomes easier and crowding out effects are likely to be lessened. The problem, of course, is the difficulty involved in persuading exploration and production companies, landowners, and other suppliers to slow development, particularly with the unpredictable nature of future commodity prices.

**Diversification** – Clearly communities can ease boom and bust cycles if they are able to diversify. However, in the midst of a natural resource upswing, it is typically not feasible to attract new industry. Existing infrastructure is already under stress, housing is in short supply, and existing workforces may be nearly tapped out. The most communities can do in the middle of a natural

resource boom is to undertake planning and then initiate those plans when activity slows down.

**Revenue Sterilization** – Local governments can moderate aggregate demand and inflation by resisting pressure to spend new tax revenues immediately and instead accumulate budget surpluses.

**Stabilization Funds** – Diverting tax revenues in order to neutralize the impact of large revenue windfall inflow has been used by many states and countries. Severance taxes in Texas generated from oil and gas production are largely diverted into the Economic Stabilization Fund (also known as the Rainy Day Fund) administered by the Comptroller's Office and the State Legislature. Along those same lines, North Dakota has established a Legacy Trust Fund to better manage the production revenues coming from the Bakken Shale. Norway's Sovereign Wealth Fund also serves a similar function.

**Investment Policy** – Government can encourage economic diversification and infrastructure development. A large portion of the taxes collected from oil and gas activity in Texas is managed by the state, not at the regional or county level. These include the bulk of the sale taxes collected, as well as severance (oil and gas production) taxes. While sales tax collections at the city and county level have increased significantly in the Eagle Ford area since drilling began, the new revenues are dwarfed by the cost of repairing or replacing existing roadways. County roads and farm-to-market road costs are about a quarter and a half a million dollars per mile, respectively, and state highway-grade roads can cost a million dollars or more per mile.<sup>1</sup> Texas recently allocated \$225 million for critical repairs to damaged roads in booming areas that include the Eagle

Ford as well as the West Texas Permian Basin area. In addition, another \$1.2 billion was added to the state's overall transportation funding in 2013 from the Economic Stabilization Fund, which has been bolstered significantly by oil and gas revenues in recent years.

In the case of Texas, decreasing production rates is unrealistic, and stabilization funds and investment policy have been implemented. Certainly, diversification will be an important strategy for rural communities in order to both avoid over-reliance on the oil and gas industry and move away from dependence on government-subsidized agriculture. More generally, rural communities must develop new industries with sustainable competitive advantages (Deller and Chicoine, 1989; Atkinson, 2004).

## 5. Methodology

This paper attempts to address concerns about sustainable development and whether counties directly affected by shale oil and gas resource abundance are benefiting (Barth, 2013). Per capita income will serve as a dependent variable that provides a straightforward measure of economic progress (Kuznets, 1955; Fodor, 2012; Jarmon, Vanderleeuw, Pennington, and Sowers, 2012) for the 14-county area where significant drilling activity has occurred. To measure relative levels of drilling and production activity in the 14-county area, this study uses the number of completed wells at the county level to determine if the initial effects of natural resource abundance are benefiting local populations. Each well completion requires dozens of workers and significant capital expenditure. With limited data in terms of both years to-date of production activity and units of analysis (14 counties), a good case can be made for employing panel data methods such as time-series, cross-section (TSCS). A suitable starting point for this analysis of the Eagle Ford data is Beck and Katz's (1995) widely-cited paper, which provides a simple methodology for analyzing TSCS data. As prescribed by Beck and Katz, data from different units (counties) have been pooled into one data set and ordinary least squares (OLS) was applied. This provides us with 56 observations.

The basic or static model takes the following form:

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \quad (1)$$

The index  $i$  refers to the total number of  $N$  observational units, in this case 14 counties in the Eagle Ford

<sup>1</sup> As an illustration, county and city level sales tax receipts for all of the counties in the Eagle Ford area showed significant increases during the 2010-2012 period. Even so, collections in 2012 ranged from \$1.7 million in Uvalde County to \$17 million in Webb County. Karnes County has seen one of the largest percentage increases in sale taxes based on an increase from \$837,038 in 2010 to \$7,961,496 in 2012. However, even if the county used all of its sales tax collections to repair or replace roads, it would amount to only about 32 miles of county roads, 16 miles of farm-to-market roads, or about 8 miles of state highway-grade roads. Further, these counties have other key infrastructure issues demanding attention, such as additional needs for police, fire and first responders, hospitals, wastewater treatment, solid waste treatment, K-12 education, and water supplies.

Shale area. The  $t$  indexes the  $T$  time periods under analysis. The data included in the TSCS analysis covers the period from 2008 until 2011, so  $T = 4$ . County-specific contribution to the dependent variable is denoted as  $\alpha_i$ . The error term  $u_{it}$  is associated with unit  $i$  at time  $t$ .

The first discovery well in the Eagle Ford was drilled in 2008 (Nicot and Scanlon, 2012), and in the 14-county area only thirteen permits were issued that year. This provides us with the basis for a natural experiment, which offers a research design that assuages potential issues associated with omitted variable bias (Hanushek and Jackson, 1977). Significant activity did not get underway until 2010, so the effects of the ramp up in production and its impact on per-capita income should be adequately captured by the models. Inclusion of annual activity prior to 2008 would increase  $T$ , the sample size, and potentially the  $t$  statistics, but without adding any useful insight into likely causality.

Even though the counties in the Eagle Ford Shale area are all rural, we cannot assume that they are homogeneous. In fact, the counties contain local factors which differ in significant ways, including population levels, highway systems, number and size of cities, proximity to large metro areas, annual rainfall, proximity to lakes/rivers, degree of use of economic development corporations, quality of governance, quality of life, degree of diversification, and others. As a result, we can expect unit heterogeneity due to unobserved independent variables. Since panel corrected standard errors (PCSEs) would not reduce the bias from employing simple OLS using pooled data (because they do not account for unobserved heterogeneity and can induce omitted variable bias) a fixed-effects model is used here. A fixed-effects model is advantageous in this case because it is unbiased with small-sample properties if the  $X_t$  regressors are exogenous and a lagged dependent variable is not included (Maddala, 1998; Wilson and Butler, 2007). Further, a lagged dependent variable is excluded from the models examined in this paper because it lacks a theoretical basis for inclusion, i.e., there is no reason to believe that per-capita income levels from previous years is the causal factor for per-capita income levels in the current year. Rather, changes in per-capita income would logically be driven by underlying economic activity. Finally, inclusion of a lagged dependent variable in and of itself artificially inflates its importance and biases significant coefficients toward negligible values (Achen, 2001).

Therefore, the fixed-effects TSCS models we will test for robustness are:

$$\text{Static model: } Y_{it} = \alpha_i + \beta_0 X_{it} + u_{it} \quad (2)$$

$$\text{Autoregressive}^2: Y_{it} = \alpha_i + \beta_0 X_{it} + u_{it}; \quad u_{it} = \rho u_{it-1} + e_{it} \quad (3)$$

$$\text{Distributed Lag: } Y_{it} = \alpha_i + \beta_0 X_{it} + \beta_1 X_{i,t-1} + u_{it} \quad (4)$$

$$\text{First Difference: } Y_{it} - Y_{i,t-1} = \alpha + \beta_0 (X_{it} - X_{i,t-1}) + u_{it} \quad (5)$$

$$\text{Classical growth: } Y_{it} - Y_{i,t-1} = \alpha + \beta_0 X_{i,t-1} + u_{it} \quad (6)$$

As mentioned earlier, a salient independent variable that can be used to attempt to validate or debunk the resource curse in this early stage of development is the number of completed wells for each year under analysis. Data for completed wells at the county level was obtained from Drillinginfo, which provides detailed information on permits and completions throughout North America. The number of completed wells is the main driver for this analysis because it represents a direct indicator of the economic activity associated with oil and gas production. The number of completed wells varies significantly by year and by county, so any effects on income should be apparent in the regression. The substantial variation of completed wells by year and by county has the characteristics of a natural experiment and acts as a form of internal control.

County population is used as one of the control variables. Because counties with larger metropolitan areas (and thus larger populations) tend to have higher incomes, we wish to control for this effect. A diversity index control variable centers on the need for industry diversification in order to promote sustainable growth. The measure of diversity used is based on employment among 15 industries in each county (as applicable) compared with shares of employment across the U.S. (Felix, 2012). A higher index value indicates relatively higher industry concentration, and thus less diversification. Communities that are heavily dependent on a single sector will likely be significantly impacted in the event of a downturn of that particular industry. In fact, natural gas production in the Barnett and Haynesville formations has not grown significantly due to the relatively low prices mentioned earlier. A drop in oil prices could have a similar impact on the Bakken in North Dakota and the Eagle Ford in South Texas.

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<sup>2</sup> For the autoregressive model,  $\rho$  is the autoregressive parameter and  $e_t$  is another random error assumed to be serially uncorrelated, homoscedastic, and have zero mean.

Therefore, controlling for the effect of industry diversification on per-capita income is warranted.

Finally, visitor spending (Klein, 2013) may contribute to income levels. It should be noted that the data captured on visitor spending represents an issue common to rapidly developing unconventional oil and gas fields – namely the difficulty in separating tourist spending from that of workers who may be living in area hotels, RV parks, and man-camps.

The use of additional control variables is necessarily limited for two reasons. Clearly the small sample size and corresponding degrees of freedom is one issue. The other has to do with model uncertainty in that we cannot be completely confident of the correctly specified model, and so it is not possible in any case to include all relevant variables in a regression equation. In essence, omitted variable bias cannot be avoided, and the inclusion of additional control variables may actually bias the coefficient being examined (Clarke, 2005). As a result, we opt for the simpler model focusing on the key inde-

pendent variable related to drilling activity and use the natural experiment research design as a control mechanism.

## 6. Discussion

The use of the models outlined above serves to make the results more robust in nature. It also highlights problems associated with the use of a single model, which can explain why multiple studies on the same topic often present contradictory results.

It is clear from the fixed effects time-series cross-section regressions in levels (Table 1) that completed wells have a direct, positive impact on per-capita income in most of the models. Given the high poverty rates of most of the counties in the Eagle Ford area and the fact that many of them were losing population before the boom, the newfound resource abundance is presenting opportunities that were once thought unattainable.

**Table 1. Static, autoregressive, and distributed lag models (dependent variable: per-capita income).**

	Completed Wells	County Population	Diversity Index	Visitor Spending	Completed Wells Lagged One Year	County Population Lagged One Year	Diversity Index Lagged One Year	Visitor Spending Lagged One Year	F Statistic
Static Model	0.203*** (0.069)								8.64***
	0.198*** (0.072)	0.000 (0.000)							4.27**
	0.167*** (0.059)	0.000 (0.000)	1.379*** (0.298)						11.42***
	0.160*** (0.058)	0.000 (0.000)	1.295*** (0.300)	0.092 (0.058)					9.52***
Autoregressive Model	0.163* (0.089)								3.33
	0.150 (0.089)	0.001 (0.001)							2.33
	0.059 (0.074)	0.001 (0.001)	1.678*** (0.399)						8.51***
	0.065 (0.075)	-0.001 (0.003)	1.495*** (0.464)	0.124 (0.156)					6.43***
Distributed Lag Model	0.289*** (0.099)				0.200 (0.149)				5.03***
	0.297** (0.114)	-0.003 (0.009)			0.180 (0.158)	0.004 (0.009)			2.45*
	0.167* (0.094)	-0.001 (0.007)	1.617*** (0.433)		0.233* (0.133)	0.002 (0.007)	0.006 (0.882)		5.62***
	0.158 (0.105)	-0.003 (0.010)	1.448*** (.501)	0.158 (0.188)	0.211 (0.140)	0.002 (0.009)	-0.199 (0.931)	0.020 (0.121)	4.12***

Note: Standard errors in parentheses. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1

The lack of industry diversity also positively influences per-capita income across several of the models. This effect appears largely due to the high

employment share in mining and extractive industries for several of the counties. Interestingly, the correlation between well completions and the diver-

sity index is very modest ( $r = 0.058$ ), so multicollinearity does not appear to be an issue with these two independent variables.

Population had no significant impact on per-capita income. Similarly, visitor spending did not have significant coefficients influencing per-capita income. With the exception of once-lagged completed wells, the remaining coefficients were not significant. In the first-difference model, completed wells was significant, but population, diversity, and visitor spending were not. In the classical growth model, no independent variables were significant.

**Table 2. First-difference model.**

First Difference Model	Completed Wells First Difference	County Population First Difference	Diversity Index First Difference	Visitor Spending First Difference	F Statistic
	28.986*** (9.304)				9.71***
	28.986*** (9.495)	-0.002 (2.811)			4.67**
	22.163* (11.860)	-0.282 (2.830)	258.13 (268.195)		3.42**
	23.021 (13.883)	-0.380 (2.990)	254.207 (275.400)	-3.641 (28.865)	2.46*

Notes: Standard errors in parentheses.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

**Table 3. Classical Growth Model**

Classical Growth Model	Completed Wells Lagged One Year	County Population Lagged One Year	Diversity Index Lagged One Year	Visitor Spending Lagged One Year	F Statistic
	73.96 (71.150)				1.08
	69.169 (74.081)	0.101 (0.332)			0.57
	93.402 (80.198)	0.112 (0.334)	385.480 (470.177)		0.60
	93.254 (81.808)	0.112 (0.341)	393.687 (482.036)	-9.679 (57.225)	0.44

Notes: Standard errors in parentheses.

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

## 7. Conclusions

The results of this research provide two findings useful for economic development practitioners. From a methodological standpoint, the characteristics of counties in the South Texas Eagle Ford Shale area clearly manifest significant heterogeneity. If this is true among contiguous county geographies within state boundaries, even greater heterogeneity may exist throughout counties across the United States. As such, this realization should serve as an

admonition that researchers must exercise caution in generalizing results across highly-aggregated units of analysis. Resource-abundant counties, for example, are also mostly non-metro counties, which tend to have below-average incomes and are often fiscally challenged to provide services supportive to economic development (Albrecht, 2012; Lobao and Kraybill, 2005). There may be interaction between the prospects for the resource curse as a result of resource abundance and the more general economic effects of low population density.<sup>3</sup>

Further research is called for in terms of gathering more systematic data that attempt to measure quality of local governance, quality of life, and environmental stewardship – both dependent and independent indicators – on a longitudinal basis in order to better gauge the progress of economic development practitioners. With potentially ambiguous results, limited data, or both, clearly the use of multiple models can improve epistemic correlation and should be the considered approach whenever possible.

Secondly, with regard to the resource curse, initial regression results suggest that incomes are rising in portions of South Texas, which is a significant development in and of itself. Through the end of 2013, nearly 9,000 oil and gas wells had been completed in the Eagle Ford. Depending on well spacing, an area where energy companies continue to experiment, estimates for the total number of wells that will be completed in the Eagle Ford range from 25,000 to 40,000. With a current completion rate of about 3,000 wells per year, these estimates imply that current levels of drilling activity could continue for five to ten years. This window of opportunity has the potential to provide the resources for other types of economic development as well as in-

<sup>3</sup> Alex and Aadland (2010) test for the resource curse by analyzing over 3,000 counties across the U.S. using annual per-capita personal income growth between 1980 and 1995 as the dependent variable. The authors attempt to control for metro vs. non-metro area (spatial correlation) by using a dummy variable for metro if the county population per square mile is greater than 300. However, under this criterion, only 18 of 254 Texas counties would qualify as metropolitan counties. With the exception of portions of the core Barnett Shale in the Fort Worth area (Tarrant County, 2004.9 persons per square mile; Denton County, 695.3 persons per square mile) and the Haynesville Shale (Gregg County, 441.4 persons per square mile), all Texas shale oil and gas fields are located in non-metro areas using the definition offered by Alex and Aadland. In the case of the Eagle Ford, population densities area range from a high of 74.2 persons per square mile (Webb County) to a low of 0.6 persons per square mile (McMullen County). Further research will be useful in untangling non-metro impacts from resource-abundance impacts.

migration, both of which can help ensure sustainability.

Given expected increases in Texas' state population, estimated to rise 58% from the current 26 million to 41 million in 2050, there may be opportunities for rural counties to counter the long-term trend of out-migration. In fact, rural South Texas counties possess several attributes that could bode well for future in-migration. Research at the state level suggests that in-migration is positively influenced by median family income, warmer climates, and higher expenditures on K-12 education (Cebula and Alexander 2006), all of which represent opportunities for South Texas community leaders.

In addition, though exact figures are unavailable, there is a significant portion of the workers in the Eagle Ford area that are commuting and are not permanent residents. Instead they live in man-camps, RV parks, and hotels while their families remain in other cities. A recent study suggests that a significant potential source of future residents is current daily commuters (Shuai, 2012). Though many commuters in the Eagle Ford are doing so on a weekly or even monthly basis, the frequent visits nonetheless enable workers to become more familiar with the area and thus lower the risk associated with relocating their families.

Opportunities for in-migration appear to be best during the next five to ten years of intensive drilling. Once the drilling activity subsides, fewer energy industry workers will be needed to monitor the ongoing production. This highlights the potential downside if communities become too dependent on a single industry such as oil and gas. With prospects such as nature, heritage/historical and recreational tourism, hunting, higher-margin agricultural production and processing, water desalination, and others, new opportunities do exist for the counties in South Texas. But these prospective opportunities in the form of non-oil and gas industries cannot yet be actively pursued – they can only be planned for because of current strains on existing infrastructure. Local mayors, city managers, economic development directors, county judges and commissioners, and other community leaders have their hands full with the pressing needs of infrastructure development *right now*. That list is long and includes roads, water, wastewater treatment, solid waste treatment, medical facilities, first responders (police, fire, medical emergency), electricity generation, K-12 education, and housing as well as broadband, improved public amenities, and aesthetics that will be needed to enhance quality of life. Yet, if the infrastructure in

South Texas is incrementally and steadily improved, it can serve as the foundation for attracting other types of industry in future years.

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