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Entry, growth and survival in the green industry

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ABSTRACT

Entry, growth and survival in the green industry. *Regional Studies*. Economists are interested in the factors that induce firm entry, lead to growth and help firms succeed in various markets. Such information can be helpful to policy-makers, but, unfortunately, such patterns have not been considered for 'green industries'. This paper takes advantage of a recent definition of green industries proposed by the US Bureau of Labor Statistics (BLS) to investigate patterns characterizing these industries within the State of Texas.

KEYWORDS

green industry; firm entry; employment growth; firm survival

摘要

绿色产业的进入、成长和生存。*区域研究*。经济学者对于在各种市场中诱发企业进入、造成成长和协助企业成功的因素很有兴趣。此般信息对政策制定者有所助益，但不幸的是，此般模式尚未考量 “绿色产业”。本文利用美国劳动统计局（BLS）晚近对绿色产业提出的定义，探讨德州内部这些产业的特徵模式。

关键词

绿色产业; 企业进入; 就业成长; 企业生存

RÉSUMÉ

L'entrée, la croissance et la survie de l'industrie verte. *Regional Studies*. Les économistes s'intéressent aux facteurs qui favorisent l'entrée des entreprises, entraînent la croissance et aident les entreprises à réussir sur divers marchés. De telles informations pourraient aider les décideurs, mais, malheureusement, on n'a pas envisagé de telles tendances pour les 'industries vertes'. Cet article profite d'une définition récente des industries vertes proposée par le US Bureau of Labor Statistics (BLS; bureau des statistiques du travail aux É-U) pour examiner les tendances qui caractérisent ces industries au sein de l'état du Texas.

MOTS-CLÉS

industrie verte; entrée d'entreprises; croissance de l'emploi; survie de l'entreprise

ZUSAMMENFASSUNG

Gründung, Wachstum und Überleben in der grünen Branche. *Regional Studies*. Wirtschaftswissenschaftler interessieren sich für Faktoren, die in verschiedenen Märkten zur Firmengründungen führen und Firmen zu Wachstum und Erfolg verhelfen. Diese Informationen können für Politiker hilfreich sein, doch leider wurden solche Muster bisher nicht für 'grüne Branchen' untersucht. In diesem Beitrag nutzen wir eine aktuelle Definition des US Bureau of Labor Statistics

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(BLS) von grünen Branchen zur Untersuchung von Mustern, die für diese Branchen im US-Bundesstaat Texas charakteristisch sind.

SCHLÜSSELWÖRTER
grüne Branche; Firmengründung; Beschäftigungswachstum; Firmenüberleben

RESUMEN
Entrada, crecimiento y supervivencia en la industria ecológica. *Regional Studies*. Los economistas están interesados en los factores que estimulan la creación de empresas y que fomentan su desarrollo y éxito en los diferentes mercados. Esta información podría ser útil para los responsables políticos, sin embargo, lamentablemente tales patrones no se han tenido en cuenta en las 'industrias verdes'. En este artículo nos aprovechamos de una reciente definición de industrias ecológicas propuesta por la Oficina Estadounidense de Estadística Laboral (BLS en sus siglas inglesas) para analizar los patrones que caracterizan estas industrias en el Estado de Texas.

PALABRAS CLAVES
industria ecológica; entrada de empresas; crecimiento del empleo; supervivencia de empresas

JEL O40, Q56, R30
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INTRODUCTION

There is widespread agreement within the developed economies that reducing the negative environmental impacts from production and consumption activities will yield net social benefits. Although progress has been made, the political side of the equation has often been complicated where strong economic interests are involved. In the United States, for example, the lack of sufficiently broad and adequately funded political coalitions at the national level has limited US participation in international efforts to control greenhouse gas emissions. Even the introduction of market-based methods, such as a market for carbon emission permits, has proven elusive at the national level. Given the political difficulties in the United States in implementing policies designed to promote sustainable activities, it is natural to ask if there are elements in the market economy that promote or favour green industrial activity in the absence of specific policy interventions. If so, policy-makers might more easily exploit such elements to pursue development of green activities. This study considers this question in the context of small geographies within Texas, a state that has demonstrated a commitment to minimal regulation and promotion of free market principles. The question is whether localized economic influences exist which favour the entry, growth and survival of green industry firms. The approach to this investigation is through a comparative analysis of green and non-green firms.

Useful insights may be achieved from such a focus on localized explanations for growth in green activities. Fitzgerald (2010) argued that without comprehensive national policy incentivizing greener forms of economic development, it is often up to cities and regions to ensure sustainable growth. She pointed out that many cities are taking the initiative to promote sustainable development and attract 'green collar' jobs. For decades, regional scientists have noted that the mix of industries is a key determinant of a location's economic performance (e.g., Isard, 1960). In a world in which the need for sustainable development is gaining momentum, it should not be surprising that local policy-makers and planners are looking to promote the entry and growth of employment in such activities. For some, indirect approaches, such as fostering a local culture of innovation, may provide more attractive avenues to a sustainable future. Rennings (2000) suggests a path by which eco-innovations can lead to sustainable development.

Kahn (2006, p. 5) claimed that 'Heavy manufacturing tends to be priced out of richer cities, giving way to relatively low-pollution industries, such as service and finance'. If so, a policy focus on high-wage employment, rather than the nature of the employment activity, may lead to the same sustainable outcome. Grodach (2011) considered the motivations and perceptions of sustainable development in the Dallas–Fort Worth area, finding that 'lack of coordinated regional planning' is a key barrier. On the other hand, Devereux, Griffith, and Simpson (2007) considered whether government subsidies (discretionary grants) affected where domestic and multinational firms located new plants. They found firms to be quite insensitive to government policies (consistent with much of the conclusion reached by those studying the pollution haven hypothesis) and more attracted to areas offering, for example, colocation benefits. This suggests that the intrinsic features of locations, whether exogenously fixed (such as resources) or endogenously determined (such as market structure and firm agglomeration), are more important. Thus, if the regulatory environment is not a factor, can it be that green industries are attracted to locations due to the popular environmental sensitivities of the locality? Some evidence for localized demand for environmental attributes was provided by Eichholtz, Kok, and Quigley (2010) who found that buildings with green ratings (characterized by Leadership in Energy and Environmental Design (LEED) or Energy Star certification) garnered significantly higher commercial office rents.

This paper takes pages from traditional industrial organization (IO) and regional economic analyses. The

IO approach is inspired by the work of Dunne, Roberts, and Samuelson (1988, 1989). The regional approach has emphasized the importance of agglomeration economies (including knowledge spillovers) to explain location choices of firms (Rosenthal & Strange, 2003; Woodward, Figueiredo, & Guimaraes, 2006), firm exits (Staber, 2001), firm and industry growth (Glaeser, Kallal, Scheinkman, & Shleifer, 1992; Henderson, Kuncoro, & Turner, 1995; Combes, 2000; De Silva & McComb, 2012b), and labour productivity (Ciccone & Hall, 1996). The analysis includes agglomeration effects (within a county as well as in contiguous counties) and knowledge spillover effects (either through firm agglomeration effects or by university and junior college research funding).

One challenge that has precluded a thorough investigation of the green industry has been the lack of a clear definition of what exactly comprises this part of the economy. This study employs a definition proposed by the Green Jobs Initiative at the US Bureau of Labor Statistics (BLS). In its classification scheme, green industries are identified at the six-digit level of the North American Industry Classification System (NAICS).[1] Note that since the BLS definition was proposed after the end of the period of analysis, there can be no endogeneity problems due to counties and municipalities attempting to attract the recently defined green industries.

This analysis focuses exclusively on the State of Texas during the period 2000–06 and employs Quarterly Census of Employment and Wages (QCEW) data. These data contain key establishment-level variables at a reasonable level of industry disaggregation. Although data limitations restrict the analysis to one state, the restriction is attractive in that environmental regulations are typically enacted at federal and state levels. As such, any differences in changes (observed or unobserved) to environmental regulations at the local level must result from regional demand.

Texas is a large and diverse economy and restricting the analysis to it is not, in fact, overly limiting. Indeed, as the second-largest state economy in the United States, Texas ranked as the 15th largest economy in the world in a comparison of countries and states by gross domestic product (GDP), surpassing many notable national economies.[2] It contains 25 metropolitan statistical areas (MSAs), of which four had populations in excess of 1 million in 2010. Texas is also a high growth state, having experienced a 20% increase in population over the period 2000–10. Income levels are quite heterogeneous across the state's localities. These characteristics allow an investigation of the relationship between local variables and firm entry, growth and exit.

There have been recent initiatives at the state level to recruit manufacturing firms to Texas, and to promote development of 'high-tech' industries directly by means of state development assistance to early stage commercialization and indirectly through assistance to the state universities. For the most part, these have occurred after the period of this analysis. In general, state legislators champion the notion of minimal government and regulation intended to alter market outcomes. Indeed, Texans often point to limited state government as a key attraction for firms looking for a place to relocate, expand or start-up. There has been greater receptivity at the local level to municipal and regional government initiatives to attract economic development. Nevertheless, Texas serves as a relatively attractive laboratory to consider market influences on the growth of sustainable economic activity.

The conclusion of this study is that the green and other industries appear to respond to similar non-policy factors. In general, entry, growth and exit patterns for green and non-green firms within a specific industry are often quite similar. Moreover, the results are fairly consistent when considering all counties in Texas compared with findings from an analysis restricted only to those counties belonging to MSAs. This suggests that rural counties do not have endowment-driven comparative advantages that are driving the results. Canonical regional science factors like agglomeration, population density and income are important in explaining firm activity. In some instances, there is a separate effect for these factors when conditioning on green firms. For example, agglomeration effects are most important in explaining firm entry and employment growth. Although agglomeration effects are, for the most part, not fundamentally different in attracting green industries, they help green employment growth in some specific industries. Concerning survival, wages, size and experience are most important to any firm for remaining in the industry. Green firms are occasionally more likely to exit compared with other firms, although this effect is sometimes weakened if the green firm has previous experience. In general, though, the green and non-green constituents of a given sector are not all that different from each other. While these conclusions might be disappointing to some, they also suggest that there are no inherent disadvantages to green industry development at the local level.

DEFINING THE GREEN INDUSTRY

On 15 July 2009, in order to measure green jobs accurately, the BLS created a discussion draft for the Workforce Information Council. The main objective was 'to produce objective and reliable information on the number of green jobs, how that number changes over time, and the characteristics of these jobs and the workers in them'. In addition to partitioning the number of jobs by industry that are associated with green goods and services (GGS) production, the BLS was interested in estimating the occupational employment and wages for establishments identified as producing these GGS. In particular, green jobs are either

- jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources; or
- jobs in which workers' duties involve making their establishment's production processes more environmentally friendly or use fewer natural resources.

The BLS identified 333 six-digit industries from the 2007 NAICS as green. This study employs the final definition that was announced in volume 75, number 182 of the Federal Register Notice.[3] For each of these industries, the BLS provided examples suggesting why the industry was included. Each individual six-digit NAICS code is reviewed to see if that industry fits with the definition of green industry or other (non-green) industry. For example, in the construction industry, the BLS identifies residential building contractors as green goods producers, but highway, street and bridge construction is not. The rationale provided is that, for the former, these builders install energy-efficient materials when building. Note that in reality not all residential builders' output is green. The data cannot identify an establishment's relative green output as done by Hoogendoorn, Guerra, and Zwan (2015), but assuming compliance with statutory building requirements, these firms produce sufficient green products to be categorized as part of the green industry.

DATA

The data for this study come from two primary sources. First, firm-level data for the State of Texas are obtained from the QCEW. The data track monthly employment and quarterly total wages reported by every establishment in the state as required under the Texas unemployment insurance programme. Each record includes the specific location (address) of the establishment, the business liability start-up date and the relevant six-digit NAICS code. Separate establishments (branches) of the same firm are distinguished and reported in unique records. This panel dataset is comprised of observations from the first quarter of 2000 (2000Q1) to the fourth quarter of 2006 (2006Q4). Each record also includes each establishment's unique employer identification number (EIN). Therefore, the appearance of a new EIN is used to define market entry and the disappearance of an EIN is treated as an exit.[4]

Since the BLS definition concerned 2007 NAICS codes but the QCEW data involve 2002 NAICS codes, the green categories are identified in the 2002 NAICS classification by employing concordances provided by the US Census Bureau.[5] Details are provided in Appendix A in the supplemental data online, which also includes Table A1 describing the variables used in the analysis. Thus, the data are consistent in terms of industry definitions and establishment assignments to industry categories for the entire period. As noted, the industry definitions to which individual establishments or particular activities are assigned predate the introduction of the BLS definition of the green industries in 2009. Lastly, given the sharp downturn in macroeconomic activity that occurred at the end of 2008, and the concomitant impact on the broader Texas economy that resulted, an analysis of localized variables' effects on establishment entry and performance in the post-2008 period could be complicated by these broader influences. Inasmuch as there does not appear to have been any substantive changes to the policy landscape at the state level in Texas since 2007 that would broadly affect establishment entry and performance of either green or brown industry firms, the period under consideration appears to be a good choice from these other perspectives.

Table 1 contains a comparison of the firm (establishment) and employment distributions across the two-digit 2002 NAICS sectors conditional on being classified as part of the brown or green industries. Numbers correspond to the percentage of green and other firms, respectively, or the share of green and other employment, averaged over the sample periods, that is attributed to each of the sectors listed – as such, the columns sum to 100%. In total, 23.32% of Texas firms are part of the green industry representing 18.01% of total employment. Agricultural firms account for a much larger share of the green industry due to the production of services, perhaps related to organic produce and meat. However, as a share of green employment, the sector is far less substantial. One-third of green firms are considered part of the construction sector, while one-quarter of green employees are construction related.

The high share of green employment in construction appears primarily due to LEED policies and Energy Star certification. For example, many six-digit 2002 NAICS sectors produce or install LEED-eligible materials or concern installation of efficient environmental control systems. Likewise, the high share of firms and employment in the professional, scientific and technical services is due to land surveying, architectural services and energy or resource-efficient design services, often relating to LEED. Although the shares of green and brown firms in the manufacturing and educational services sectors are comparable, the shares of green employment in these sectors far outranks that of brown employment, suggesting these green firms are larger than their brown counterparts within these two-digit sectors, at least on average. Educational services at the six-digit codes defined as 'junior colleges' and 'colleges and universities' are both considered part of the green industry since they provide training for green jobs.[6]

Figure 1 maps the average green intensity for each county – a relative measure computed as the number of green firms in a county over the number of other firms in a county. For reference, the 25 MSAs (using the largest city) are labelled, as identified by the US Census Bureau based on population. Surprisingly, some counties have more green firms than brown firms, as indicated by a green intensity greater than 1. A map considering an employment-based measure of the green intensity has the same qualitative features.

Accounting for agglomeration effects will be important in this analysis. The number of firms is the count from the previous period, essentially the number of incumbents, within the 'own-county' and neighbouring counties, used to construct agglomeration variables. The neighbouring aggregates help capture spillover effects between contiguous counties. To account for other factors that might be important in explaining firm entry, employment growth or firm survival, the QCEW data are complemented with data from other sources. Specifically, county-level data, such as population density, were collected from the US Census Bureau's Annual Population Estimates. The

Table 1. Distribution of green and other industry activity across sectors.

NAICS-2 title	Establishments		Employment	
	Other	Green	Other	Green
Agriculture	0.19	7.47	0.07	2.68
Mining	1.74	–	2.25	–
Utilities	0.18	1.70	0.31	3.51
Construction	0.48	33.82	0.96	24.99
Manufacturing	4.86	5.13	8.23	19.37
Wholesale	9.33	0.44	5.77	0.39
Retail	17.87	1.05	15.76	0.48
Transportation	3.95	0.36	5.51	1.55
Information	1.43	3.39	2.50	5.36
Finance	7.97	0.19	5.75	0.07
Real estate	5.90	–	2.23	–
Scientific	5.03	27.03	1.96	15.50
Management	0.13	0.73	0.06	1.65
Waste management	4.87	4.35	8.09	3.25
Education	1.12	1.05	6.71	14.18
Health care	12.41	–	13.51	–
Arts and entertainment	1.28	0.40	1.01	1.04
Accommodation	9.61	–	10.36	–
Other	9.98	10.32	2.31	3.43
Public administration	1.65	2.57	6.65	2.58

Note: NAICS, North American Industry Classification System.

average quarterly county income is calculated by taking the average wages paid in the county for all establishments reported in the QCEW data. Income seems not only to be a natural attractor of firm investment, but may be particularly important for green investment and/or employment: if demand for green goods is income elastic, then higher incomes would induce a proportionally greater increase in demand for GGS. The empirical models specified below allow for income to have a different influence on the green industry compared with the non-green industry.

In addition to the agglomeration and income effects, this study also investigates whether the presence (and size) of a research centre affects the green industry. Having research universities provides access to expert consultants

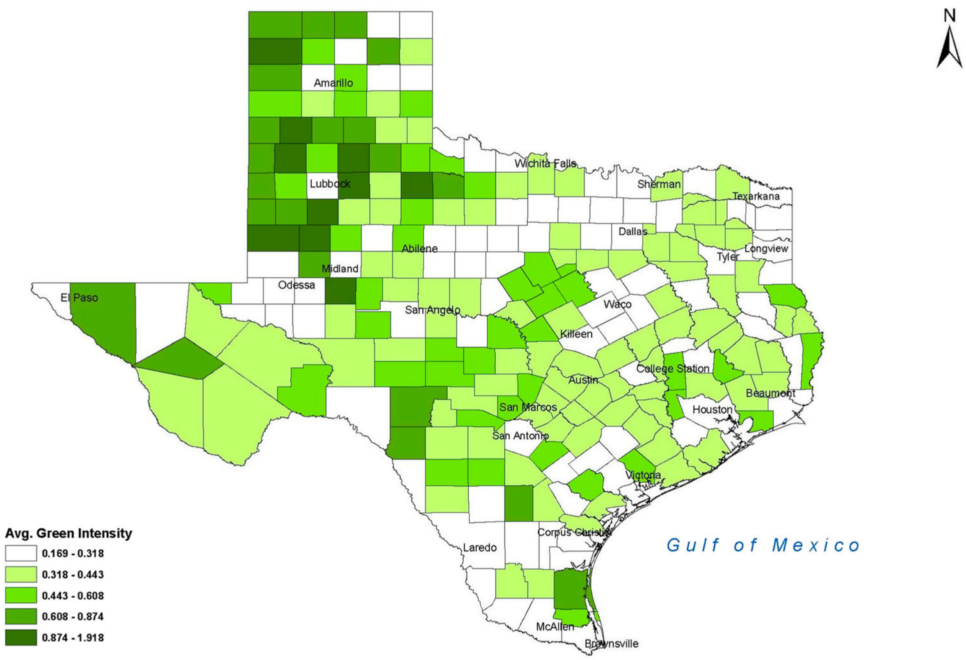

Figure 1. Average distribution of green firm intensity.

and allows for specialized funding sources which may play a significant role in attracting green industries. For example, Abramovsky, Harrison, and Simpson (2007) found evidence that business-sector research and development activity is often located near university research departments. In order to capture such effects, the local presence of a four-year university, junior college or research institution is included. Data on annual university research and development (R&D) expenditures were obtained from the National Science Foundation.

Yearly median undeveloped land price is employed to account for factor costs, as in Bresnahan and Reiss (1991). These values are collected for each of 33 land market regions (composed of aggregations of counties) in Texas by the Texas A&M Real Estate Center. Since this variable does not change across quarters and is common to groups of counties, the county-specific property tax rate is also included. Lastly, as Woodward et al. (2006) suggested, cultural and natural amenities are important for industrial attraction and skilled workforce retention. To capture this effect, as in De Silva and McComb (2012a), the share of county employment in local cultural and recreational amenities is used as a measure of the locality's urban amenities. While natural amenities may be valued, urban amenities are both more immediate and relevant to day-to-day life for full-time employed individuals. These activities also reflect the scope of the locality's amenities for business travellers as well as for informal business and social interaction.

All QCEW variables are observed across the 28 quarters constituting the data sample for each of Texas' 254 counties. Entry, exit and employment variables are aggregated based on the green industry definition (and our green-other partition), yielding 14,224 (= $28 \times 254 \times 2$) observations, two per county in each quarter for the industry analysis.

EMPIRICAL MODELS AND ESTIMATION

This section describes the formal econometric models and estimates that are used to help understand the relationship between regional variables and the green (or non-green) industries. In the spirit of Dunne et al. (1988, 1989), the interest is in firm entry, employment growth and survival. This section is further subdivided into three subsections corresponding to each of these topics.[7]

Entry

Firm entry helps promote competition and improve efficiency. An immediate impact of new firms on a local economy is that they allow for job creation. This section describes the enquiry into the factors that are correlated with new firm entry with particular emphasis on whether the effects of these factors differ between the green and non-green sectors.

To the greatest possible extent, a canonical set of explanatory variables that has appeared in the IO and regional economics literatures is used. There has been interest in both fields in spatial effects, expressed through agglomeration economies that attract firms and exhibit a self-reinforcing tendency toward industrial growth. Agglomeration effects are captured by computing the number of firms already in an industry within a given county at a given time. Agglomeration can be particularly important in location decisions when proximity to market is not a dominant factor. Thus, where localization leads to pooling of labour, facilitation of communication among suppliers, access to intermediate inputs and technological spillovers, an existing industry concentration increases the attractiveness of a locality for an establishment surveying areas in which to locate. Any clustering of green industries may also be the result of a deeper regional environmental consciousness insofar as it reflects social receptivity and interest in green activities. While it is not possible to account explicitly for local attitudes toward 'going green' given the data, county fixed effects are used to help capture unobserved, county-specific effects that were constant throughout the data period. Similarly, quarter-specific fixed effects are used to capture the possibility that these attitudes (or other factors, such as the overall health of the United States and Texas economies) are changing over time in all counties. Note also that since all models are estimated by NAICS industry, the estimations also implicitly include industry effects.

To consider factors that affect entry (firm investment), counts of the number of firms within each industry (or subcategory) that entered each county in a given quarter are included within a Poisson specification. For the Poisson case, Gourieroux, Monfort, and Trognon (1984) showed that a consistent and asymptotically normal estimator can be obtained without specifying the probability density function of disturbances. Wooldridge (1999) showed that the fixed effects Poisson estimator is consistent and asymptotically normal as long as

$$\mathrm{E}(y_{i_g jt}|\alpha_j, x_{i_g jt}; \beta) = \alpha_j \exp(x'_{i_g jt}\beta)$$

where, in the present case, $y_{i_g jt}$ represents the number of entering green or other firms in industry i_g, in county j, at time t; and α_j is the fixed effect for county j. Furthermore, Wooldridge derived a robust covariance matrix for the Poisson quasi-maximum likelihood (QML) estimator with conditional fixed effects. Thus, given an interest in the effects of the explanatory variables on the mean response, a Poisson model is estimated by QML. While the estimated coefficients obtained from Poisson QML estimation are identical to Poisson regressions with fixed effects, the standard errors are adjusted for overdispersion.[8]

Table 2 reports results from 16 models estimated via Poisson QML in which robust standard errors are reported. These models are intended to uncover any differences in the entry behaviour between green and non-green firms within an industry. All models include, as conditioning variables, measures of county income, agglomeration within a county (computed as the number of like firms already present in the county of a certain type – green or other by industry), agglomeration in neighbouring (contiguous) counties, university and junior college funding for each county, the county unemployment rate, the population density of the county, the property tax rate of the county, the undeveloped land price for the market region to which the county belongs, as well as county and time-fixed effects to account for county-level and time-specific unobserved heterogeneity.[9]

The most consistent results concern agglomeration being an important factor in explaining firm entry – the more like firms, the more likely firms are to enter the area. This is consistent with List (2001) (as well as others cited above in the introduction) who found that agglomeration is a factor in driving firm entry. However, it can be seen that in most sectors agglomeration does not encourage green entry any differently when compared with non-green industry entrants. The exceptions to this are the agriculture and utilities sectors, for which green firms are less likely to locate in areas with a high number of existing green firms. This is somewhat expected. Consider a county with high-quality wind power resources. Once wind-generating farms are developed in areas best suited for wind power generation, potential entry is reduced as the key resource, accessible windy terrain, is in fixed supply. The same goes for a gas or coal electricity-generating plant that, at efficient scale, meets the county demand. On the other hand, being green seems to amplify the agglomeration effects for the manufacturing and finance industries. There is no evidence of knowledge spillovers (beyond that captured by the agglomeration variables) in attracting new firms nor consistent support of other variables such as unemployment rate and undeveloped land prices. However, population density is another key factor in explaining firm entry as demand will of course increase with population.

Although income shows a primarily significant effect on entry overall, its effect is quite mixed, depending on the sector that is interacted with the green industry dummy. For example, the manufacturing and information sectors are more likely to see green entrants for higher incomes. In contrast, green waste management and remediation service establishments are highly likely to enter low-income areas. These establishments may provide hazardous waste-removal services and, therefore, choose to locate near firms that produce such discharge. De Silva, Hubbard, and Schiller (2016) recently showed that polluting firms in Texas, as identified by the US Environmental Protection Agency (USEPA), locate in low-income, high-minority population areas. Therefore, a similar pattern should be seen with these waste management and remediation service establishments. The results in this paper suggest that these remediation establishments are indeed more likely to locate in low- compared with high-income areas.

The Poisson QML models are re-estimated as a robustness check using the ordered probit technique. Here the dependent variable takes values 0, 1, 2 and 3 when a specific industry for a given county at time t observes no entrants, one entrant, two entrants and three or more entrants respectively. Qualitative results are quite similar to what is observed in the Poisson models. As mentioned above, all models are estimated for the MSA counties only. The models were also estimated using only the green and the non-green establishments (which have the advantage of essentially interacting the green dummy variable with each of the covariates). This would be analogous to the approach taken by List and Co (2000). All these results are available from the corresponding author upon request.

Employment growth

To evaluate whether there are differences in the growth of the green and other industries, a simple regression model is utilized to explain the percentage change in industry employment of the counties. Specifically, in comparing the green and other industries within a two-digit NAICS code, the estimation uses a fixed-effects model with AR(1) disturbances, introduced by Baltagi and Wu (1999), which can be stated as follows:

$$\log(E_{i_g jt} + 1) = x'_{i_g jt}\beta + \alpha_{i_g} + \gamma_j + \theta_t + \varepsilon_{i_g jt}$$

$$\varepsilon_{i_g jt} = \rho\varepsilon_{i_g jt-1} + \eta_{i_g jt}$$

where $|\rho| < 1$ and $\varepsilon_{i_g jt}$ is independent and identically distributed with mean zero and variance σ^2_η. The industry-specific (green and other) fixed-effects parameter is α_{i_g}. The parameters γ_j and θ_t account for county- and time-specific unobserved heterogeneity. The term $E_{i_g jt}$ denotes total employment in industry i_g, in county j, during period t. As controls, the same set of variables used to estimate the entry models described above are included.

Given space constraints, the results from estimation of these regression models are presented in Appendix A in the supplemental data online. Because the full and restricted (MSA-only) sample results are at least qualitatively similar, the results are interpreted in a way that applies to both samples. In general, agglomeration effects are always positive and significant; being green amplifies this except in the agriculture and information sectors. Likewise, income almost always has a positive effect on employment growth; its effect is often negative when interacted with the green dummy and in several cases this effect offsets the overall income effect. The two effects go in the same direction for the agriculture and information sectors. Being populous spurs growth in a statistically significant way in all but the agriculture sector. Aside from these primary results, other variables are occasionally significant but the sign and magnitude of the effects varies across industries. Alternative formulations were considered, including models with the logarithm of industry (subcategory) employment as the dependent variable and the logarithm of total (green industry) employment as an explanatory variable (the assumption being that green or other employment differ from the trend in total employment). Other models that tried to explain variation in the share of industry employment in the green and other industries were also estimated, and had qualitatively similar estimation results. However, the interpretation of the coefficients differs and is more complicated given the interest in employment growth and not changes in the composition of employment which may 'improve' even though employment is decreasing. These

Table 2. Poisson quasi-maximum likelihood (QML) estimation results concerning the number of entrants.

(a)

	Number of entrants$_{i_g,j,t}$							
Variable	**Agriculture (1)**	**Utilities (2)**	**Construction (3)**	**Manufacturing (4)**	**Wholesale (5)**	**Retail (6)**	**Transportation (7)**	**Information (8)**
Green industry	5.490**	2.281	–0.515	–4.419**	6.282*	–0.708	–3.507	–6.919***
	(2.458)	(3.837)	(1.832)	(1.943)	(3.732)	(2.034)	(6.703)	(2.047)
Log (income)$_{j,t-1}$	0.790	1.341	0.977***	2.015***	2.430***	–0.162	0.822*	1.180*
	(0.536)	1.809)	(0.351)	(0.605)	(0.373)	(0.322)	(0.434)	(0.624)
Log (income)$_{j,t-1}$ × Green industry	–0.393	–0.150	0.231	0.387*	–1.019**	–0.235	–0.015	0.774***
	(0.279)	(0.461)	(0.223)	(0.229)	(0.442)	(0.248)	(0.739)	(0.240)
Log (agglomeration)$_{i_g,j,t-1}$	1.229***	0.426	0.637***	0.163	0.604***	0.031	–0.179	0.092
	(0.202)	(0.264)	(0.145)	(0.100)	(0.093)	(0.117)	(0.217)	(0.121)
Log (agglomeration)$_{i_g,j,t-1}$ × Green industry	–1.181***	–0.384*	–0.066	0.157***	0.138*	–0.062	0.006	–0.093
	(0.187)	(0.221)	(0.091)	(0.050)	(0.082)	(0.072)	(0.087)	(0.066)
Log (agglomeration in neighbours)$_{i_g,j,t-1}$	–0.357**	–0.134	–0.029	–0.054	–0.003	0.153*	0.203**	–0.101
	(0.165)	(0.253)	(0.126)	(0.055)	(0.068)	(0.084)	(0.100)	(0.095)
Log (agglomeration in neighbours)$_{i_g,j,t-1}$ × Green industry	0.556***	0.061	0.078	–0.107**	0.036	–0.027	–0.020	–0.055
	(0.134)	(0.196)	(0.072)	(0.043)	(0.071)	(0.058)	(0.091)	(0.057)
Log (college funds)$_{j,t-1}$	–0.012	–0.083*	–0.001	–0.013	0.004	0.008	–0.002	–0.008
	(0.015)	(0.045)	(0.004)	(0.010)	(0.005)	(0.010)	(0.006)	(0.010)
Log (junior college funds)$_{j,t-1}$	–0.002	0.004	–0.002	0.000	–0.004*	–0.003	0.002	0.001
	(0.009)	(0.014)	(0.002)	(0.004)	(0.002)	(0.003)	(0.004)	(0.005)
Log (population density)$_{j,t-1}$	1.225***	1.454**	0.704***	1.615***	0.498***	1.142***	1.641***	2.832***
	(0.238)	(0.735)	(0.158)	(0.248)	(0.053)	(0.181)	(0.209)	(0.382)
Unemployment rate$_{j,t-1}$	–0.012	0.173*	0.014	0.011	0.083***	–0.012	0.065***	0.014
	(0.037)	(0.095)	(0.018)	(0.040)	(0.024)	(0.021)	(0.023)	(0.047)
Property tax rate$_{j,t-1}$	0.331	–2.514	–0.005	–1.159*	–0.295	–0.112	–0.377	0.372
	(0.440)	(1.432)	(0.296)	(0.659)	(0.376)	(0.311)	(0.419)	(0.863)
Log (undeveloped land price)$_{j,t-1}$	0.183	0.430	–0.110	0.069	–0.095	0.297***	–0.210**	0.033
	(0.172)	(0.445)	(0.086)	(0.151)	(0.092)	(0.080)	(0.092)	(0.182)
Amenities employment ratio$_{j,t-1}$	1.840	–4.449	–0.486	2.737	4.321***	0.241	–1.650	6.174*
	(1.908)	(5.322)	(1.223)	(2.669)	(1.594)	(1.313)	(2.069)	(3.589)
County effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,224	14,224	14,224	14,224	14,224	14,224	14,224	14,224
R^2	0.469	0.463	0.979	0.899	0.983	0.976	0.944	0.869

(b)

Variable	Finance (1)	Scientific (2)	Management (3)	Waste (4)	Education (5)	Arts (6)	Other (7)	Public administration (8)
	Number of entrants$_{i_g,j,t}$							
Green industry	5.763	0.177	10.697**	8.036***	7.845**	15.987***	3.111***	–1.165
	(4.722)	(0.831)	(5.194)	(1.159)	(3.929)	(4.823)	(1.184)	(3.140)
Log (income)$_{j,t-1}$	0.063	0.650*	5.479**	1.145***	2.576***	1.032	0.114	0.803
	(0.464)	(0.332)	(2.496)	(0.429)	(0.879)	(0.766)	(0.302)	(0.897)
Log (income)$_{j,t-1}$ × Green industry	–1.392**	–0.009	–1.132*	–1.007***	–0.851*	–2.237***	–0.468***	0.028
	(0.578)	(0.098)	(0.600)	(0.139)	(0.493)	(0.575)	(0.142)	(0.386)
Log (agglomeration)$_{i_g,j,t-1}$	0.011	0.378***	0.161	0.455***	0.595***	–0.039	0.225**	–0.518
	(0.162)	(0.110)	(0.326)	(0.087)	(0.213)	(0.164)	(0.095)	(0.347)
Log (agglomeration)$_{i_g,j,t-1}$ × Green industry	–0.049	0.013	0.170	–0.058	0.033	–0.113	0.018	–0.204
	(0.232)	(0.029)	(0.269)	(0.040)	(0.209)	(0.224)	(0.025)	(0.177)
Log (agglomeration in neighbours)$_{i_g,j,t-1}$	–0.116	0.038	0.066	–0.141**	–0.097	–0.178	–0.011	0.049
	(0.131)	(0.082)	(0.285)	(0.068)	(0.312)	(0.123)	(0.087)	(0.308)
Log (agglomeration in neighbours)$_{i_g,j,t-1}$ × Green industry	0.446***	0.002	–0.111	0.025	–0.163	0.065	–0.047**	0.036
	(0.173)	(0.026)	(0.224)	(0.031)	(0.224)	(0.178)	(0.022)	(0.132)
Log (college funds)$_{j,t-1}$	0.001	0.003	0.063	0.016***	–0.056	0.001	–0.006	–0.010
	(0.005)	(0.005)	(0.070)	(0.005)	(0.041)	(0.011)	(0.004)	(0.028)
Log (junior college funds)$_{j,t-1}$	0.000	–0.001	0.002	–0.003	–0.002	–0.001	0.002	0.001
	(0.003)	(0.002)	(0.014)	(0.003)	(0.009)	(0.005)	(0.002)	(0.015)
Log (population density)$_{j,t-1}$	3.007***	1.049***	1.041***	1.467***	1.484***	3.641***	1.344***	1.360***
	(0.363)	(0.126)	(0.236)	(0.159)	(0.502)	(0.482)	(0.241)	(0.474)
Unemployment rate$_{j,t-1}$	0.036	0.009	–0.093	0.012	–0.015	0.023	0.038**	0.146**
	(0.032)	(0.020)	(0.237)	(0.024)	(0.066)	(0.046)	(0.019)	(0.070)
Property tax rate$_{j,t-1}$	–0.354	0.006	1.659	–0.209	–1.040	2.046***	–0.109	–0.556
	(0.672)	(0.345)	(2.146)	(0.380)	(1.024)	(0.765)	(0.315)	(0.926)
Log (undeveloped land price)$_{j,t-1}$	–0.079	0.022	0.173	–0.025	–0.044	0.407**	–0.034	–0.146
	(0.096)	(0.076)	(0.442)	(0.092)	(0.214)	(0.193)	(0.076)	(0.365)
Amenities employment ratio$_{j,t-1}$	–0.019	0.546	–6.443	–2.087	7.574	9.023***	1.181	5.242
	(2.108)	(1.407)	(11.320)	(1.785)	(7.637)	(2.518)	(1.263)	(3.248)
County effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,224	14,224	14,224	14,224	14,224	14,224	14,224	14,224
R^2	0.976	0.978	0.372	0.975	0.642	0.885	0.980	0.154

Note: ***Statistical significance at the 1% level; **statistical significance at the 5% level; *statistical significance at the 10% level. Robust standard errors are given in parentheses.

results are available from the corresponding author upon request.

Firm survival

Lastly, the probability of exit by green and other establishments is estimated using simple probit models. Only establishments that entered since 2000Q1 are included. This allows an examination of the full life cycle of plants. This approach eliminates any concerns about left censoring, and possible selection biases arising from it. Right censoring is accounted for in the estimation procedure. Note that this is now an establishment-level analysis.

There are 33,494 green construction establishments that have entered since 2000Q1. Of these firms, 14,486 exited during the sample period. There are 8197 firms that had past experience in the same industry. An entrant firm seems quite small at start-up, averaging only about nine employees at the initial stage. These establishments tend to stay in the market for about 20 months. Average initial wage per quarter is about US$8810. Similar patterns can be observed for other industries as well. Considering industries, more green entrants are observed for agriculture, utilities, construction, manufacturing and management relative to non-green firms.

Exit results are reported in Appendix A in the supplemental data online and the covariates are the same as those included in the authors' earlier econometric models. The main interest is in the coefficient of an indicator variable for green firms. It indicates that green agricultural, construction, waste management and other sector plants tend to have higher exit probabilities compared with non-green firms in the same industry. However, green finance and arts sector establishments have a lower probability of exit compared with non-green firms in the same two-digit NAICS codes. Flexibility of the probit model allows the researcher to add time effects and age as covariates. In general, establishments with higher wage rates, larger firms and older firms have lower exit rates. These results are in line with the existing literature (e.g., Dunne, Klimek, & Roberts, 2005). Beyond these effects, no clear picture emerges across all industries concerning the other variables.

CONCLUSIONS

Taking as given the BLS definition of the green industries, this analysis compares features of these industries with that of all other industries over a consistent period. In general, there is little evidence that localized factors that encourage entry, growth or exit are inherently different for green and non-green firms within two-digit NAICS codes. Indeed, localized agglomeration within a county seems to be the primary factor in attracting and growing firms of all types. Of particular note is the absence of regional income as a significant, positive explanatory variable when interacted with the green indicator variable. This result stands in contrast to any assertion that demand for environmental quality and/or sustainability is income elastic. Economists have also provided evidence of an environmental Kuznets curve (EKC) that depicts an inverted 'U'-shaped relationship between various pollution measures and levels of economic activity (e.g., Grossman & Krueger, 1995). In the spirit of the empirical research on the EKC, alternative empirical models in which income enters as a polynomial were estimated. No significant differences were found from what is herein already reported, suggesting that local income effects are not essential in the development of localized green activities.

Texas represents an attractive opportunity to isolate market effects on green industry entry, growth and exit. This investigation of localization and market factors that affect the green industries suggests that there are no inherent reasons, beyond regional agglomeration, to expect an expansion in green activities without specific non-market policy interventions. While this analysis cannot speak of the efficacy of various policies designed to attract green firms as, for example, Palmer and Burtraw's (2005) comparison of policies aimed at increasing the contribution of renewables to the total US electricity supply, it might be concluded that reliance on steadily increasing household incomes and follow-on market effects will not likely produce satisfactory results for areas that are looking to expand the share of sustainable economic activities at the local or regional level.

These results should give pause to advocates of a strictly market approach to growing a green economy. Clearly, the basic mechanics of localized markets, in the absence of specific policy interventions, are similar across the developed world. While cultural attitudes and institutional environments differ, unregulated market responses are probably quite similar across localities. Thus, local policy-makers, in the absence of state or national policy interventions, will need to pursue localized policy options to achieve objectives in the expansion and share of green activities in local and regional economies. This analysis can be conducted at any level of geographic/spatial aggregation, or in any country, as long as appropriate data are available. However, some degree of acuity is lost as the level of spatial aggregation increases.

One could leverage variation in policies across states (in either a sub-national or an international evaluation, given most environmental policies are set at the federal level) or across countries to consider the costs and benefits of policies aimed at encouraging sustainable development. Such policy-specific research would provide a valuable contribution in complementing this analysis. Given the finding that green and other industries do not respond in markedly different ways to non-policy factors, there may be an especially key role for policy-makers in areas wanting to stimulate green investment and growth.

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SUPPLEMENTAL DATA

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NOTES

1. See http://www.bls.gov/green/.
2. Gross domestic products (GDPs) for countries were obtained from Central Intelligence Agency (CIA) (2013); GDP for states came from the US Bureau of Economic Analysis (BEA).
3. See http://www.bls.gov/green/final_green_def 8242010_pub.pdf or the official industry list.
4. Following Dunne et al. (2005), some EINs appear in a given quarter but are associated with previous EINs which are not treated here as new. The change in EIN may have occurred because the establishment changed hands, a partnership was broken or for any number of other reasons. The firm survival analysis controls for these 'firms with past experience'.
5. See http://www.census.gov/eos/www/naics/concordances/concordances.html/.
6. Unfortunately, while the BLS justified its classifications of which sectors belonged in the green industry, no rationale was provided for why some sectors were not part of the green industry. The authors assume no special insight concerning the classification of the green and other industries and take the BLS definition as given. Appendix A in the supplemental data online provides two tables with additional summary statistics of interest: one characterizing the distribution of firms and employees by green and other sectors, the other showing the average number of entrants and incumbents over these partitions and within various two-digit NAICS codes.
7. Readers may wonder whether the findings in going forward are inherently different for MSA counties than for the State of Texas as a whole. The authors will gladly provide estimates of models using a restricted sample involving only counties that are in a Texas MSA upon request. This restriction is motivated by the clear observation that most entry occurred around population centres. The results are not qualitatively different.
8. Simcoe (2007) provides an implementation of the Poisson QML model with conditional fixed effects suggested by Wooldridge (1999).
9. In explaining entry, all right-hand-side variables were lagged by a quarter to reflect the county environment at the time each new firm considered entering. Table A1 in Appendix A in the supplemental data online describes how each variable was constructed.

REFERENCES

Abramovsky, L., Harrison, R., & Simpson, H. (2007). University research and the location of business R&D. *Economic Journal*, *117*(519), C114–C141. doi:10.1111/j.1468-0297.2007.02038.x

Baltagi, B. H., & Wu, P. X. (1999). Unequally spaced panel data regressions with AR(1) disturbances. *Econometric Theory, 15*, 814–823.

Bresnahan, T. F., & Reiss, P. C. (1991). Entry and competition in concentrated markets. *Journal of Political Economy*, *99*(5), 977–1009. doi:10.1086/261786

Central Intelligence Agency (CIA). (2013). *The world factbook 2013–14*. Washington, DC: CIA.

Ciccone, A., & Hall, R. E. (1996). Productivity and the density of economic activity. *American Economic Review*, *86*(1), 54–70.

Combes, P.-P. (2000). Economic structure and local growth: France, 1984–1993. *Journal of Urban Economics*, *47*(3), 329–355. doi:10.1006/juec.1999.2143

De Silva, D. G., Hubbard, T. P., & Schiller, A. R. (2016). Entry and exit patterns of 'toxic' firms. *American Journal of Agricultural Economics*, *98*(3), 881–909. doi:10.1093/ajae/aaw012

De Silva, D. G., & McComb, R. (2012a). Research universities and regional high-tech firm start-up and exit. *Economic Inquiry*, *50*(1), 112–130. doi:10.1111/j.1465-7295.2010.00353.x

De Silva, D. G., & McComb, R. P. (2012b). Geographic concentration and high tech firm survival. *Regional Science and Urban Economics*, *42*(4), 691–701. doi:10.1016/j.regsciurbeco.2012.03.001

Devereux, M. P., Griffith, R., & Simpson, H. (2007). Firm location decisions, regional grants and agglomeration externalities. *Journal of Public Economics*, *91*(3–4), 413–435. doi:10.1016/j.jpubeco.2006.12.002

Dunne, T., Klimek, S. D., & Roberts, M. J. (2005). Exit from regional manufacturing markets: The role of entrant experience. *International Journal of Industrial Organization*, *23*(5–6), 399–421. doi:10.1016/j.ijindorg.2005.01.011

Dunne, T., Roberts, M. J., & Samuelson, L. (1988). Patterns of firm entry and exit in U.S. manufacturing industries. *RAND Journal of Economics*, *19*(4), 495–515. doi:10.2307/2555454

Dunne, T., Roberts, M. J., & Samuelson, L. (1989). The growth and failure of U.S. manufacturing plants. *Quarterly Journal of Economics*, *104*(4), 671–698. doi:10.2307/2937862

Eichholtz, P., Kok, N., & Quigley, J. M. (2010). Doing well by doing good? Green office buildings. *American Economic Review*, *100*(5), 2492–2509. doi:10.1257/aer.100.5.2492

Fitzgerald, J. (2010). *Emerald cities: Urban sustainability and economic development*. New York: Oxford University Press.

Glaeser, E. L., Kallal, H. D., Scheinkman, J. A., & Shleifer, A. (1992). Growth in cities. *Journal of Political Economy*, *100*(6), 1126–1152. doi:10.1086/261856

Gourieroux, C., Monfort, A., & Trognon, A. (1984). Pseudo maximum likelihood methods: Applications to Poisson models. *Econometrica*, *52*(3), 701–720. doi:10.2307/1913472

Grodach, C. (2011). Barriers to sustainable economic development: The Dallas–Forth Worth experience. *Cities*, *28*(4), 300–309. doi:10.1016/j.cities.2011.02.006

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *Quarterly Journal of Economics*, *110*(2), 353–377. doi:10.2307/2118443

Henderson, V., Kuncoro, A., & Turner, M. (1995). Industrial development in cities. *Journal of Political Economy*, *103*(5), 1067–1090. doi:10.1086/262013

Hoogendoorn, B., Guerra, D., & Zwan, P. (2015). What drives environmental practices of SMEs? *Small Business Economics*, *44*(4), 759–781. doi:10.1007/s11187-014-9618-9

Isard, W. (1960). *Methods of regional analysis*. Cambridge, MA: MIT Press.

Kahn, M. E. (2006). *Green cities: Urban growth and the environment*. Washington, DC: Brookings Institution Press.

List, J. A. (2001). US county-level determinants of inbound FDI: Evidence from a two-step modified count data model. *International Journal of Industrial Organization*, *19*(6), 953–973. doi:10.1016/S0167-7187(99)00051-X

List, J. A., & Co, C. Y. (2000). The effects of environmental regulations on foreign direct investment. *Journal of Environmental Economics and Management, 40*(1), 1–20. doi:10.1006/jeem.1999.1095

Palmer, K., & Burtraw, D. (2005). Cost-effectiveness of renewable electricity policies. *Energy Economics*, *27*(6), 873–894. doi:10.1016/j.eneco.2005.09.007

Rennings, K. (2000). Redefining innovation: Eco-innovation research and the contribution from ecological economics. *Ecological Economics*, *32*(2), 319–332. doi:10.1016/S0921-8009(99)00112-3

Rosenthal, S. S., & Strange, W. C. (2003). Geography, industrial organization, and agglomeration. *Review of Economics and Statistics*, *85*(2), 377–393. doi:10.1162/003465303765299882

Simcoe, T. (2007). *XTPQML: Stata module to estimate fixed-effects Poisson (quasi-ML) regression with robust standard errors* (Working Paper). Statistical Software Components, Boston College Department of Economics.

Staber, U. (2001). Spatial proximity and firm survival in a declining industrial district: The case of knitwear firms in Baden-Wurttemberg. *Regional Studies*, *35*(4), 329–341. doi:10.1080/00343400125106

Woodward, D., Figueiredo, O., & Guimaraes, P. (2006). Beyond the Silicon Valley: University R&D and high-technology location. *Journal of Urban Economics*, *60*(1), 15–32. doi:10.1016/j.jue.2006.01.002

Wooldridge, J. M. (1999). Distribution-free estimation of some nonlinear panel data models. *Journal of Econometrics*, *90*(1), 77–97. doi:10.1016/S0304-4076(98)00033-5