Rural versus Urban: Determinants of the Firm-level Innovation Gap

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Abstract
Using a firm-level data from urban and rural enterprises (n=8,136) provided by USDA's *National Survey of Business Competitiveness*, we explore factors contributing to the rural-urban firm innovation gap. Our study considers 40 measures of innovation captured by the survey: from initial inputs (such as R&D), to intermediate outputs (such as patents), to final outputs (such as increased market share), and a wide range of other firm characteristics. We use these measures to identify similarities and differences in both innovation and characteristics of rural and urban firms. We conduct our analyses explaining these differences, first by constructing logit models for each category of innovation, controlling for firm age, labor structure, capital structure, industry, and census region, and then employing a Cragg hurdle model to estimate factors associated with number of patents. Based on this analysis, we find significant differences between rural and urban firms in only 6 of the 40 (15%) innovation measures, indicating that firm-level characteristics and/or industry account for most of the observed variation between urban and rural firms. The five most important factors to the rural-urban innovation gap are in order, the portion of the workforce in production, firm age, the portion of the workforce in natural resources-construction-maintenance, whether the firm offers paid maternity leave, whether the firm offers health insurance, and total employment. Firm-level controls account for 92.6% of the rural-urban innovation gap while industry dummies account for only 7.4%. In terms of the number of patents by patenting firms, offering health care coverage was significant and positive, while the urban dummy was not significant at either stage of the Cragg model. One policy implication of our analysis might be that improvements to rural firm innovation may need to be focused more on rural firm characteristics and less on the rates of innovation adoption and creation.

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Introduction

In the wake of the 2016 federal election, commentators noted that rural areas disproportionately voted to change the party of the Presidency from Democratic to Republican (O'Brien and Ahearn, 2016). Clearly, rural voters were discontent with past policies. While some of these policies probably relate to other social issues, the economic gap between rural and urban areas reversed the convergence trend observed in earlier decades and widened in the years since the early 2000s (O'Brien and Ahern, 2016). Innovation is a driver of economic change, and rural areas are often characterized as lagging in innovation. A classic textbook driver of agglomeration economies is information flows about innovation. As noted by Glaeser (2010, p. 1), "a central paradox of our time is that in cities, industrial agglomerations remain remarkably vital, despite ever-easier movement of goods and knowledge across space." The promise of the information age seems to have left rural America behind, at least in terms of its impact on closing the income gap. Is lack of innovation a driver of those differences? Is rural innovation really slower or otherwise different, than urban innovation?

A commonly used indicator of innovation is patenting activity. However, in rural areas, innovation may not be worth patenting, if for example, the innovation relates to a process that is highly specific to the region or if producers sense that sharing information amongst themselves can help gain market share or achieve critical mass in distribution systems. Thus patenting may not be as appropriate for measuring rural innovation as it might be in urban areas. A parallel question is whether rural firms fail to innovate, or whether they are simply in sectors where there is less innovation nationally. For example, according to the USDA (2017), total factor productivity in agriculture has been stagnant for the past decade, so one might naturally expect firms active in production agriculture to be patenting less than other firms. There may be natural plateaus achieved as innovations are exploited. Alternatively, the increasingly deep science base of agriculture may be driving more innovation in the sector to urbanized areas, (e.g., St. Louis, headquarters of Monsanto). Armed with a stronger understanding of the nature of rural innovation, policy makers can begin to determine how policies might be adapted to address rural stagnation.

In this paper, we employ a survey of over ten thousand businesses, some urban, some rural, to explore urban and rural differences in innovation patterns. The survey went beyond the commonly employed patent measures of innovation to collect information on many other ways that firms tend to innovate. Using econometric techniques to control for firm characteristics, we find significant differences between rural and urban firms in only 8 of the 40 (20%) innovation measures, indicating that firm-level characteristics account for most of the observed variation between urban and rural firms.

Background

At the turn of the 21st century, rural policy was focused primarily on agriculture and manufacturing, yet neither of these policies were effective at supporting rural America's ability to be resilient, self-sufficient, or competitive (Acs and Malecki 2003; Markley 2001; Renski and Wallace 2012; Stauber 2001). In fact, there were two primary concerns regarding these rural policies. First, the economic literature does not support federal agriculture policy aimed at producer subsidies and research addressing issues related to production efficiency, nor does it support local policies focused on manufacturing plant recruitment (Renski and Wallace 2012; Stauber 2001). Second, federal agriculture-related polices may have actually hurt rural areas by using limited resources directed to rural areas on agriculture—assuming that agriculture and rural are the same—and, therefore, limited rural areas from establishing a competitive advantage (Johnson and Rathge 2006; Stauber 2001). This crowding out may impact rural manufacturing or service industries, or possibly simply move activity within agriculture from the private to the public sector.

Historically, there are four general areas in which rural firms, have been at a disadvantage relative to urban firms (Henderson, 2002; Porter, et al., 2004; Renski and Wallace, 2012). First, the size (population) and remoteness of rural areas impacts their respective firms' abilities to establish economies of scale. This included local markets for goods and services produced as well as transportation infrastructure necessary to acquire necessary production inputs. Second, until the onset of the internet, rural firms had limited access to new technology and knowledge. For some rural areas today, this continues to be a problem. Third, firms in rural areas faced difficulties accessing venture capital and private equity needed to launch or expand operations. Fourth, rural entrepreneurs did not have the same level of management or technical skills, relative to urban entrepreneurs, to create and sustain high-growth businesses. While many of these factors have linkages to agglomeration effects (Acs and Varga 2005; Audretsch 1998), or lack of, they contribute to observations of an innovation gap between firms operating in rural versus urban areas (Acs and Malecki 2003; Henderson 2002; Porter, et al. 2004; Renski and Wallace 2012; Rubin 2010; Quigley 2002).

On the other hand, there were opportunities for entrepreneurship growth in rural areas (Henderson, 2002; Porter, et al., 2004). More specifically, there was a movement to encourage entrepreneurship as a strategy for sustained economic growth for rural communities (Hanham, Loveridge and Richardson, 1999; Dabson 2001; Drabenstott and Henderson 2006; Henderson 2002). The general idea was that rural entrepreneurship strategies could promote endogenous growth, which in turn could help rural communities retain more local talent. The motivation behind the idea: encouraging entrepreneurship is cost-effective alternative to tax abatement schemes that attempt to lure larger employers from other areas but risk eroding the tax base, hampering future investments in education and infrastructure. The challenge implementing endogenous growth in rural areas is policies that simply focus on new firm creation are not enough. All forms of entrepreneurship may create jobs but not regional growth (Henderson 2002; Goetz et al. 2010; Shane 2009). For example, in areas with high levels of unemployment or underemployment, necessity entrepreneurship may be the predominant options. Lifestyle entrepreneurs, who may view their enterprise as a hobby or a means of subsistence but who do not envision expansion, are another commonly observed form in rural areas. Finally, some entrepreneurs may have the desire to grow but lack capacity to do so. The main point is that the formulation of polices may need to do a better job of connecting entrepreneurship to innovation. The reason for the specific focus on innovation, and not just firm creation, is that with few exceptions, only high-growth and innovation-based (either in process, product, or management technique) entrepreneurs are likely to lead to a means of sustained economic growth (Lichtenstein and Lyons 2010; Aghion and Howitt 1990; Goetz et al. 2010; Shane 2009).

Drucker (2005) describes innovation as "the means by which [entrepreneurs] exploit change as an opportunity for a different business or a different service" (p. 19). From a broader view, the impact from firms exploiting innovation is a key consideration regarding sustained growth because innovation-based entrepreneurship can lead to more innovation-based entrepreneurship (Aghion and Howitt 1990; Goetz et al. 2010; Shane 2008). Further, innovation-based entrepreneurship can also lead to opportunities or gaps to fill for other, non-innovative forms of entrepreneurship. For example, the introduction of a new product can create the need for new part suppliers, new housing for workers, new retail stores and restaurants, and so on through the normal downstream and upstream linkages familiar to regional economists. From the perspective of policy makers, this makes ramping up efforts to increase innovation appear very attractive. However, the type of entrepreneurship occurring in rural areas, for the most part, was not high-growth or innovation-based (Henderson 2002; Stauber 2001)[1] leading some researchers to distinguish between "entrepreneurs" and "business owners" (Levine and Rubinstein, 2017). Thus, policies were needed to encourage innovation activity that improve and strengthen: (1) entrepreneurs' individual-level skills; (2) community resources; and (3) resource networks for entrepreneurs.

The specific nature of the innovation gap at the firm level is described by Renski and Wallace (2012), and they identified five characteristics that distinguished rural from urban firms:

1. Ownership structure: new rural firms were more frequently sole proprietors, and less likely to establish a formal legal structure;
2. Growth: new rural firms created fewer jobs during the observation period;
3. Industry mix: new rural firms entry was more likely in low-tech industries;
4. R&D and innovation adoption/creation: rural firms were less likely to invest in R&D and less likely to seek IP protection; and
5. Sales and revenue: rural firms were more likely to sell a product or service, and generate revenues in the first year.

These findings supported earlier works of Barkley, Henry, and Lee (2006) and Henderson and Abraham (2004) who, for example, also identified restricted industry mix as a limiting factor to innovative activity. These two studies also recognized proximity to metro areas, and access to labor pools with scientific researchers also impact rural firms' ability to produce R&D leading to new innovations. These results are also similar to studies that did not uniquely focus on rural areas, but considered firm characteristics of innovative (e.g., patent holding) and non-innovative (non-patent-holding) firms. For example, the decision to seek profits by selling goods or services is a business strategy that could eliminate a firm's ability to obtain future venture capital and potentially become less innovative (Freedman, 2013; Graham, Merges, Samuelson, and

[1] The point here is that high-growth or innovation-based entrepreneurship is fundamental to achieve sustainable economic growth (Aghion and Howitt, 1990; Mann and Shideler 2015; Shane, 2008)

Sichelman, 2009). Additionally, ownership structure may impact decision making regarding a firm's business model. Thus, the combination of many of these factor may be contributing to observations of lower rural firm innovation rates and slower growth relative to urban firms.

Data

Our data come from the 2014 National Survey of Business Competitiveness (NSBC) (Wojan, 2015).[2] The survey, administered by mixed mode, contacted 53,234 US businesses requesting completion of questions by mail, internet, or telephone. The response rate was 22.4%. The target respondent was a firm with more than five employees, operating in the mining, manufacturing, manufacturing, wholesale trade, transportation and warehousing, information, finance and insurance, professional/scientific/technical services, arts, or management of business. In its paper form, the survey was sixteen pages long; the questions covered a wide array of location and business operation items. The sample was stratified by firm size categories, NAICS codes, and whether the location of the firm was metropolitan or non-metropolitan. More detail on the survey questions and implementation is available in Wojan (2015).

The NSBC data itself consists of 53 questions, resulting in 257 variables for each respondent. The questions concern: location factors, labor structure, education distribution, information and technology usage, sales, improvements and innovations, failed innovations, research and development, green innovations, patent and intellectual property activity, effects of the 2008-2009 recession, market share, location-based barriers, local government impact, and capital structure. 48.2% of the questions were binary response, 37.4% of the questions were multiple response beyond two, and 14.4% were open response.

Ignoring null responses, the data consists of 10,913 observations. Of those, 1,943 responses were dropped because the respondent failed to complete the survey or did not report the location of their firm. 834 responses were dropped from our analysis because the respondent answered that they were not familiar or only slightly familiar with innovation at the firm. There were n=8,136 responses remaining.

The sample was designed so that one fourth of the responses would be from urban firms and three fourths of the responses would be from rural firms (i.e., firms located in rural counties according to metropolitan status in the census code). Accordingly, 25.2% of the firms are in metropolitan counties and 74.8% of firms are in nonmetropolitan counties.

From the NSBC data, we identified 40 indicator variables which we considered to be measures of innovation. We selected 20 a subset of 20 of these measures to be included in this paper by agreeing before the analysis which we felt most important and/or unique. Results for all 40 measures are provided in the supplementary materials.

Table 1 shows the means of 20 indicator variables we selected, the number of observations for urban and rural firms, and the differences along with two sample t-tests results for significant

[2] *This survey is also referred to as the Rural Establishment Innovation Survey (REIS), not to be confused with the Bureau of Economic Analysis data of the same name.*

differences. In 30 of the 40 variables, we were able to detect significant differences between the urban and the rural samples at the 1% level (34/40 at the 5% level). In only one case (the variable was an indicator for resources available for innovation during the financial crisis years 2008-2009) did we find that rural firms showed more innovation than urban firms. In all other cases we found either no significant differences or significantly more innovation in urban firms than in rural firms. These differences are evidence of the NSBC data of a rural-urban innovation gap. Our model, described below, helps understand some of the possible reasons for the gap.

Modeling Approach

The modeling approach for this paper consists of two parts. The first part is a standard logit model for most of the innovation variables, which are binary outcomes. The second part is a Cragg (1971) hurdle regression for the number of patents.

First, the innovation indicators were modeled using a traditional binary variable approach:

$$y_i = \mathbf{1}(y_i^* \geq 0) \tag{1}$$

for $i = 1, \dots, n$ where y_i is a measure of innovation and y_i^* is the unobserved latent variable associated with y_i. The linear specification selected[3] for the latent variables from Eq. (1) was defined as

$$y_i^* = \alpha_{NAICS(i)} + \theta_{region(i)} + metro_i\beta + \boldsymbol{X}_i'\boldsymbol{\gamma} + metro_i\boldsymbol{X}_i'\boldsymbol{M}'\boldsymbol{\omega} + \epsilon_i \tag{2}$$

for $i = 1, \dots, n$ where $\alpha_{NAICS(i)}$ is a fixed effect for the 3-digit NAICS industry code for firm i, $\theta_{region(i)}$ is a fixed effect for the census region (1 to 4) for firm i, $metro_i$ is an indicator for whether or not the firm is located in an urban county, $\boldsymbol{X}_i$ is an $r \times 1$ vector of firm-level characteristics/question responses, M is an $r \times 3$ vector reducing the number of interactions to three,[4] β, $\boldsymbol{\gamma}$, and $\boldsymbol{\omega}$ are 1×1, $r \times 1$, and 3×1 vectors of estimated coefficients, and ϵ_i is a stochastic error.

The $\boldsymbol{X}_i$ variables selected for the model include the firm's age, labor structure (i.e., size, part-time to total employment ratio, employee benefits, and occupational distribution), and capital structure (i.e., borrowing from debt, equity, and personal sources and re-investing of past profits). In total, we included r=25, $\boldsymbol{X}_i$ variables. While this number may seem large, recall the data has n=8,136 responses.

The coefficients were estimated using logit regression in Stata. This specification was selected to test for difference between urban and rural firms controlling for the firm's census region, NAICS code, and firm-level characteristics.

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[3] Various models were considered including different fixed effects profiles including state-level fixed effects and coarser NAICS code specifications. Detailed statistics on these specifications can be found in the Appendix.
[4] Three interactions were selected by modeling various selections and *F*-testing for significant differences. Details can be found in the Appendix.

Second, the integer valued patent counts were modeled using a Cragg (1971) hurdle model as follows:

$$\ln y_i = metro_i b + \boldsymbol{X}_i'\boldsymbol{g} + metro_i \boldsymbol{X}_i' \boldsymbol{M}'\boldsymbol{w} + e_i \text{ if } y_i^* \geq 0 \quad (3)$$

otherwise $y_i = 0$ for $i = 1, \ldots, n$ where y_i is and y_i^* is the unobserved latent variable associated with y_i as in Eq (1). y_i^* is estimated using the same specification as in Eq. (2). b, $\boldsymbol{g}$, and $\boldsymbol{w}$ are 1×1, $r \times 1$, and 3×1 vectors of estimated coefficients, and ϵ_i is a stochastic error. e_i and ϵ_i are assumed to be uncorrelated. While this assumption may not strictly hold in this data, we hope that by including a variety of firm-level characteristics we can tease out most of the correlation in the errors.

The Cragg hurdle model (Eq. 3) assumes that firms first decide whether or not to patent at all. Once a firm has decided to patent its innovations, the firm then chooses how many patents for which it is going to apply. This model allows for many firms to produce zero patents while still estimating a non-flat regression curve for the firms that do choose to patent. In Eq. (3) (i.e., the non-zero portion of the model), we did not include industry-level and region-level fixed effects. The reason for this decision is that only 6% of our sample produced any patents. There were simply not enough data points to control for industries at that level.

Results

In Table 2, we present the estimated coefficients from the logit models from Eq. (1) and (2) using the 20 innovation variables. For the purposes of this paper, the most important finding is that after controlling for 3-digit NAICS industry and the selected firm-level characteristics, we are only able to detect significant differences on the urban dummy variable in 6 of the 40 models at the 5% and in only 2 of the 40 models at the 1% level. The only model in which we detect significant differences which is in the subset of 20 variables shown in Table 2 is innovation resources from the 2008-2009 period and rural areas where rural firms show more innovation than urban firms (as was the case in Table 1). The other case where the urban dummy was found to be significant at the 1% level was for the question: “In the past 3 years, did this business purchase knowledge or expertise to implement innovations?” For this question, the urban dummy was estimated to be 0.45. We excluded this variable from the 20 we selected (before the analysis) because we felt that this was an indirect measure of innovation.

The variables that are most often significant are provided here. Most often significant was whether or not the firm offered paid professional education/development at 33/40 models at the 1% level (36/40 at the 5% level). Offering paid education was found to increase innovation at the firm, as would be expected. Similarly, offering paid maternity leave was positively significant in 32/40 models at the 1% level (34/40 at 5%). Older firms were found to show more innovation where firm age was significant in 22/40 models at the 1% level (26/40 at 5%). Firms offering paid volunteer time were found to have higher rates of innovation where the coefficient was significant in 17/40 models (23/40 at 5%). Firms that were at least partly financed be reinvested profits were found to show more innovation and this was significant in 15/40 models (18/40 at

5%). Firms with more total employees were found to have more innovation and the coefficient was significant in 14/40 models at the 1% level (21/40 at 5%). Firms employing a smaller portion of part-time workers were found to exhibit more innovation where the coefficient was significant in 13/40 models (20/40 at 5%). Difficulty hiring qualified employees, offering health insurance, and the interaction between urban location and total employment were found to be significant in 6, 4, and 3 of the 40 models respectively (12, 5, and 9/40 at 5%). Only seven other variables were found to be significant in any one or two of the 40 models at the 1% level.

Because including firm-level variables and industry fixed effects seems to greatly reduce, perhaps even eliminate, the rural-urban innovation gap, we can then explore how differences within the firm-level variables contribute to presence of this gap in the data before controlling. To this end, we compare firm-level means of the explanatory variables in Table 3. Combining mean differences with information about estimated coefficients from Table 2, we find that the five most important factors to the rural-urban innovation gap are in order, the portion of the workforce in production, firm age, the portion of the workforce in natural resources/construction/maintenance, whether the firm offers paid maternity leave, whether the firm offers health insurance, and total employment. Of these five top factors, two are within control of a firm in question and potentially policy makers and economic development professionals: the decisions to offer paid maternity leave and health insurance. Urban firms tend to offer these benefits more often than rural firms, and these are likely to be key drivers of innovation at the firm level. Encouraging businesses to offers these benefits through incentives may have a serious impact on the quality of employees that firms can hire which may ultimately help to close the rural-urban innovation gap.

Similarly to Table 3, Table 4 shows rural-urban differences but this time between the NAICS industry codes that were controlled for in Eq. (2) via fixed-effects. Table 4 also shows the average fixed-effects from across the 40 different models so that the rural/urban differences can be evaluated in relation to the impact it has on overall innovation. Three of these categories have differences which contribute negatively to the rural-urban innovation gap: transportation and warehousing, mining and oil/gas extraction, and finance and insurance. While differences in these sectors is interesting, these difference are not as important as those from the firm-level controls. Using back-of-the-envelope style approximation (as used in the last two paragraphs already) we are able to measure the relative importance of the firm-level controls versus the industry fixed effects. We find that the firm-level controls from Table 3 account for 92.6% of the rural-urban innovation gap while the industry dummies account for only 7.4%.

Table 5 shows the results from the Cragg (1971) hurdle model for the number of patents. Because only 6% of the firms in our data produced any patents at all, we report the 10% and 5% significance levels in Table 5 instead of the 5% and 1% used earlier. In the second stage of the hurdle model, we find that only four variables are significant even at the 10% level. The decision to offer health insurance is significant at the 10% level and comparable to the first stage (similar to the logit models from Eq. 1 and 2). The decision to offer an employee ownership plan is significant at the 5% level and also comparable to the first stage. The portion of the workforce in the natural resources, construction, and maintenance is significant at the 5% level and positively associated with producing more patents whereas it was negatively associated with the decision to patent in the first stage. Also interestingly, whether or not the firm used reinvested profits to finance the business was significant at the 10% level and negatively associated with producing more patents whereas it was positively associated with the decision to patent in the first stage. The coefficient on the urban dummy was not found to be significant in either stage at the 10% level. This leads to the tentative conclusion that our firm-level controls can account not only for the rural-urban innovation gap across the extensive margin of the firm but also across the intensive margin, at least in the case of patent activity.

Summary and Conclusion

The goal of this study is to compare rural and urban firm innovation across a broad range of innovation metrics and firm characteristics. Our motivation is twofold. First, while rural firms, and thus rural areas, are observed to have lower rates of innovation creation and adoption we wanted to see if this observation is true across a vast number of innovation measures—as many as possible. Second, if this is the case we wanted to shed light on the reason why. The modeling approach occurred in two parts, comparing rural and urban firms across 40 different innovation measures (logit model) and then distinguished between firms that chose to pursue patents and those that did not (hurdle model). Our primary finding is that once controlling for firm-level characteristics and industry, the difference in levels of innovation between rural and urban firms disappear.

Some of the rural-urban differences can be explained by the level of intensity in the sector, which naturally falls from rural character. For example, it is difficult to perform mining, oil, and gas extractive functions in urban areas due to externalities. Thus rural areas are more invested in a sector with negative average fixed effects. Also, our data exclude farm operations, and there may be substantial differences in the nature of innovation in agricultural production.

Still, our findings have implications for broader policy and future research. The fact that health insurance is related to innovation in the firm should be noted by policy makers engaged in the current national debate on health care. Is health insurance merely a proxy for other characteristics of the firm not captured in the data, or is health insurance required by people capable of innovation? Would a move to, or away from, national health insurance make it more difficult for firms wishing to innovate to provide signals to potential employees who have ability to innovate? Or is the mechanism found here different? Does providing health insurance somehow make the firm more prone to innovate, perhaps in an effort to reduce its costs by minimizing its workforce?

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Table 1: Selected Innovation Variables and Significant Differences Tests

Variable	Urban		Rural		Differences
	n	Mean	n	Mean	Mean
Improved: Goods	1,388	0.64	4,325	0.57	0.068**
Improved: Services	1,777	0.72	5,320	0.67	0.045**
Improved: Manufacturing	1,421	0.58	4,337	0.54	0.040**
Improved: Performance	1,793	0.60	5,155	0.57	0.032*
Improved: Features	1,790	0.57	5,159	0.55	0.024
Improved: Variety	2,034	0.69	6,021	0.65	0.038**
Improved: Market share	2,032	0.61	6,005	0.54	0.065**
Reduced: Labor costs	2,007	0.33	5,977	0.32	0.008
Reduced: Material inputs	1,999	0.24	5,959	0.24	-0.004
Abandoned innovations	2,024	0.26	5,931	0.21	0.051**
In-house R&D	1,824	0.50	5,274	0.43	0.073**
Purchase R&D	1,821	0.16	5,272	0.11	0.046**
Purchase patents	1,820	0.10	5,270	0.08	0.020*
IP: Patents	1,979	0.08	5,863	0.06	0.023**
IP: Industrial designs	2,035	0.04	6,019	0.03	0.015**
IP: Trademarks	2,035	0.16	6,013	0.09	0.069**
IP: Copyright	2,028	0.19	6,000	0.11	0.077**
IP: Trade secrets	2,025	0.30	6,006	0.18	0.127**
Inn. Resources: '08-'09	1,833	0.66	5,384	0.69	-0.030*
Inn. Resources: '13-'14	2,037	0.92	6,004	0.91	0.009

*-significant at the 5% level; **-significant at the 1% level

Table 2: Coeffients for Estimated Probit Models for Innovation Measures on Firm-Level Characterisitics

Independent variable	Dependent variable									
	Imp. goods	Imp. services	Imp. manu.	Imp. perf.	Imp. feat.	Imp. variety	Imp. mkt. sh.	Red. labor	Red. inputs	Abandoned inn.
Firm age	-0.009**	-0.005*	-0.005	-0.004	-0.002	-0.011**	-0.014**	-0.004	-0.005	-0.006*
Total employment	0.002**	0.001	0.001**	0.001*	0.001*	0.001*	0.004**	0.001*	0.001**	0.001
PT/Total ratio	-0.300	-0.370	-0.450	-0.170	-0.330	-0.300	-0.370	-0.53**	-0.63**	-0.69**
Health insurance	-0.120	0.000	-0.130	0.000	0.040	-0.020	0.050	0.010	0.110	0.080
Retirement plan	-0.120	-0.040	-0.120	0.090	0.010	0.060	0.140	-0.020	-0.060	0.030
Paid prof. development	0.36**	0.47**	0.36**	0.40**	0.36**	0.38**	0.56**	0.27**	0.20*	0.38**
Paid maternity	0.27**	0.30**	0.27**	0.25**	0.17*	0.130	0.21**	0.21**	0.32**	0.35**
Employee ownership	0.330	0.090	0.240	0.40*	0.190	0.260	0.35*	0.120	0.41**	0.030
Paid volunteer time	0.080	0.120	0.130	0.20*	0.150	0.120	0.38**	0.18*	0.30**	0.000
Portion in management	0.760	1.380	-1.030	-1.080	-0.220	0.600	-1.180	-1.860	-1.450	-0.820
Portion in service	0.520	2.200	-0.700	-1.110	-0.180	1.220	-1.410	-1.760	-1.460	-0.500
Portion in sales	0.850	1.730	-0.730	-0.730	0.170	1.480	-0.500	-1.820	-1.530	-0.430
Portion in nat. resources	0.860	1.730	-0.560	-0.810	-0.360	1.100	-0.960	-1.580	-0.920	-0.760
Portion in production	0.880	1.360	-0.380	-1.360	-0.360	1.020	-0.700	-1.200	-0.870	-0.230
Unionized labor	-0.160	-0.200	0.250	0.180	-0.120	-0.090	-0.270	0.320	0.170	0.220
Difficulty hiring	0.21*	0.18*	0.160	0.130	0.120	0.080	0.17*	-0.100	0.070	0.38**
Tried debt financing	0.190	0.41*	0.100	-0.010	0.080	-0.070	0.36*	0.160	0.170	0.120
Tried equity financing	0.150	0.080	-0.360	0.330	-0.130	0.300	0.70*	0.150	0.170	0.330
Tried personal financing	-0.430	-0.210	0.160	-0.67*	-0.120	0.010	-0.060	0.080	0.310	0.67*
Succeeded in debt	-0.300	-0.210	-0.060	0.070	0.040	0.260	-0.010	-0.090	-0.130	0.000
Succeeded in equity	-0.100	0.210	0.490	-0.200	0.310	0.000	-0.340	0.000	-0.030	-0.230
Succeeded in personal	0.700	0.460	0.030	0.77*	0.220	0.250	0.350	0.100	-0.150	-0.170
Reinvested profits	0.180	-0.010	0.200	0.46**	0.56**	0.170	0.31**	0.200	0.33**	0.33**
Profits gr or eq. borrowed	-0.030	0.130	-0.030	-0.010	0.100	0.080	0.090	-0.050	-0.200	-0.31*
Profits gr. borrowed	-0.060	0.130	-0.020	0.010	-0.140	0.080	0.30**	0.100	0.040	0.150
Urban dummy	0.270	-0.080	0.040	0.140	-0.110	0.120	0.160	0.110	0.110	-0.020
Int. 1: Urban/Total emp.	-0.002**	0.002	0.002	0.000	-0.001	-0.001	-0.001	-0.001	-0.001*	0.000
Int. 2: Urban/Management	0.420	0.110	0.030	0.250	0.62*	0.220	0.430	0.110	0.310	0.240
Int. 3: Urban/Service	0.070	0.350	0.280	-0.390	0.060	-0.110	0.010	0.050	0.010	0.490
R-Squared	0.264	0.241	0.237	0.325	0.293	0.259	0.282	0.289	0.215	0.201

*-significant at the 5% level; **-significant at the 1% level

Table 2: Coeffients for Estimated Probit Models for Innovation Measures on Firm-Level Characterisitics (Continued)

Independent variable	Dependent variable									
	In-H. R&D	Purc. R&D	Purc. patents	IP. patents	IP. ind. designs	IP. TM.	IP. copyrights	IP. trade sec.	Inn. res. 08-09	Inn. res. 13-14
Firm age	-0.011**	-0.004	-0.012**	-0.018**	-0.017**	-0.011**	-0.006	-0.018**	-0.003	-0.003
Total employment	0.001	0.001	0.000	0.000	0.000	0.002**	0.001	0.001**	0.000	0.000
PT/Total ratio	-0.410	-0.430	-0.97**	-0.98*	-1.41**	-1.04**	-1.31**	-0.56*	0.100	-0.080
Health insurance	0.110	0.140	0.220	0.73**	0.63*	0.40**	0.170	0.59**	-0.100	0.230
Retirement plan	0.030	0.070	0.080	0.270	0.330	0.37**	0.100	0.20*	0.070	0.27*
Paid prof. development	0.41**	0.64**	0.250	0.49**	0.310	0.24*	0.22*	0.61**	-0.040	0.200
Paid maternity	0.36**	0.46**	0.46**	0.49**	0.66**	0.46**	0.43**	0.28**	0.020	0.170
Employee ownership	0.49**	0.57**	0.57**	0.65**	0.240	0.38*	0.270	0.250	0.130	0.010
Paid volunteer time	0.28**	0.23*	0.40**	0.240	0.370	-0.030	0.190	-0.020	0.070	0.160
Portion in management	-0.140	-2.880	-3.490	-4.710	-5.250	-2.560	-0.050	-3.010	0.370	1.470
Portion in service	-0.460	-3.270	-2.990	-5.500	-4.670	-2.700	-0.800	-3.720	0.330	1.240
Portion in sales	-0.290	-2.880	-2.850	-4.900	-4.780	-1.510	0.250	-2.790	0.480	0.980
Portion in nat. resources	0.210	-2.260	-2.320	-5.320	-4.760	-2.930	-1.57*	-3.440	0.510	1.670
Portion in production	0.380	-2.650	-2.760	-4.800	-4.060	-2.050	-0.030	-2.830	0.110	1.370
Unionized labor	-0.160	0.100	0.070	0.230	-0.440	0.090	-0.340	0.250	-0.300	0.120
Difficulty hiring	0.110	0.010	-0.030	-0.38*	-0.260	-0.040	-0.090	0.100	-0.28**	-0.230
Tried debt financing	-0.060	0.140	-0.090	0.340	-0.620	0.260	0.41*	0.070	-0.32*	-0.150
Tried equity financing	-0.060	0.510	0.110	0.140	0.530	0.90**	0.200	0.550	0.230	-0.200
Tried personal financing	0.300	0.040	-0.020	-0.100	0.460	-0.520	0.680	-0.340	-0.520	-0.780
Succeeded in debt	0.010	-0.140	0.270	-0.450	0.090	-0.220	-0.330	-0.110	0.140	0.220
Succeeded in equity	0.370	-0.440	0.140	0.140	-0.060	-0.600	-0.110	-0.280	-0.490	0.080
Succeeded in personal	-0.080	0.000	0.010	0.420	-0.060	0.880	-0.290	0.790	0.230	0.290
Reinvested profits	0.30**	-0.020	0.040	0.440	0.230	0.310	0.210	0.33*	-0.080	-0.200
Profits gr or eq. borrowed	0.150	0.210	0.330	-0.220	0.090	-0.120	-0.050	-0.050	0.230	0.300
Profits gr. borrowed	0.000	0.050	-0.210	-0.070	-0.120	0.110	0.140	0.190	-0.130	-0.020
Urban dummy	-0.010	0.240	-0.040	-0.390	-0.230	0.210	0.310	0.320	-0.45**	0.380
Int. 1: Urban/Total emp.	0.001	0.000	0.000	0.000	0.000	-0.001*	0.000	0.000	0.000	0.000
Int. 2: Urban/Management	0.490	0.230	0.890	1.43*	1.750	0.940	0.240	0.560	0.370	-0.640
Int. 3: Urban/Service	0.390	0.590	0.280	0.380	0.610	0.590	0.410	0.630	0.74**	-0.200
R-Squared	0.264	0.241	0.237	0.325	0.293	0.259	0.282	0.289	0.215	0.201

*-significant at the 5% level; **-significant at the 1% level

Table 3: Urban and Rural Differences for Explanatory Variables

Variable	Urban		Rural	
	Obs	Mean	Obs	Mean
Firm age	1,971	22.99	5,732	27.53
Total employment	2,054	56.65	6,082	47.07
PT/Total ratio	2,054	0.90	6,082	0.92
Health insurance	2,051	0.81	6,064	0.70
Retirement plan	2,041	0.61	6,056	0.59
Paid prof. development	2,044	0.63	6,054	0.63
Paid maternity	2,039	0.39	6,031	0.33
Employee ownership	2,046	0.08	6,057	0.05
Paid volunteer time	2,045	0.19	6,032	0.22
Portion in management	2,038	0.30	6,024	0.23
Portion in service	2,038	0.24	6,024	0.25
Portion in sales	2,038	0.22	6,024	0.18
Portion in nat. resources	2,038	0.03	6,024	0.06
Portion in production	2,038	0.21	6,024	0.28
Unionized labor	2,051	0.04	6,062	0.03
Difficulty hiring	2,038	0.19	6,049	0.27
Tried debt financing	1,970	0.51	5,780	0.54
Tried equity financing	1,970	0.17	5,780	0.15
Tried personal financing	1,970	0.20	5,780	0.18
Succeeded in debt	1,978	0.44	5,831	0.48
Succeeded in equity	1,978	0.15	5,831	0.14
Succeeded in personal	1,978	0.19	5,831	0.17
Reinvested profits	2,032	0.77	6,000	0.76
Profits gr or eq. borrowed	1,962	0.86	5,748	0.85
Profits gr. borrowed	1,962	0.55	5,748	0.51
Urban dummy	2,054	1.00	6,082	0.00

Table 4: Two-digit NAICS Industry Differences between Urban and Rural Areas and Associated Average Fixed-Effects from Logit

Code	NAICS Category	Mean			Avg. FE
		Urban	Rural	Diff.	
21	Mining, Oil/Gas Extraction	0.009	0.029	-0.020	-0.542
33	Manufacturing	0.243	0.322	-0.079	0.180
42	Wholesale Trade	0.212	0.174	0.038	0.001
48	Transp, Warehousing	0.051	0.092	-0.041	-0.713
51	Information	0.044	0.083	-0.039	0.111
52	Finance, Insurance	0.031	0.038	-0.007	-0.347
54	Prof, Sci, Tech Services	0.338	0.208	0.130	-0.280
55	Management	0.040	0.024	0.016	-0.353
71	Arts, Ent, Recreation	0.031	0.030	0.001	-0.091

Table 5: Cragg Hurdle Model Results for Number of Patents (Log s

Independent variable	Coefficients Stage 1	Stage 2	Marginals
Firm age	-0.009**	0.001	-0.002**
Total employment	0.000**	0.000	0.000*
PT/Total ratio	-0.45**	-0.06	-0.13*
Health insurance	0.27**	0.38*	0.12**
Retirement plan	0.100	0.150	0.05*
Paid prof. development	0.30**	0.100	0.09**
Paid maternity	0.27**	-0.010	0.07**
Employee ownership	0.32**	0.35**	0.13**
Paid volunteer time	0.080	-0.020	0.020
Portion in management	0.310	0.250	0.060
Portion in service	-0.070	0.040	-0.060
Portion in sales	0.050	0.230	-0.010
Portion in nat. resources	-0.320	1.24**	0.030
Portion in production	0.030	0.140	-0.030
Unionized labor	-0.020	0.060	0.000
Difficulty hiring	-0.130	0.020	-0.030
Tried debt financing	-0.110	-0.320	-0.070
Tried equity financing	0.320	-0.290	0.040
Tried personal financing	-0.090	-0.170	-0.050
Succeeded in debt	-0.090	0.170	0.000
Succeeded in equity	-0.040	0.230	0.020
Succeeded in personal	0.120	0.310	0.080
Reinvested profits	0.160	-0.33*	0.000
Profits gr or eq. borrowed	0.000	0.300	0.040
Profits gr. borrowed	-0.100	0.070	-0.020
Urban dummy	-0.120	0.230	0.000
Int. 1: Urban/Total emp.	0.000	0.000	0.000
Int. 2: Urban/Management	0.54*	0.220	0.17*
Int. 3: Urban/Service	0.140	-0.460	-0.030

*-significant at the 10% level; **-significant at the 5% level