Innovative Business Practices and the Performance of Rural Establishments: Identifying Frontier Performers

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Expanded employment opportunities, innovation, and productivity are closely linked to new businesses but the early stages of entrepreneurship are not easily researched and consequently not well understood. Dinlersoz et al. (2023) stress the local origins of business formation and assess the spatial disparity in the creation of business ideas and the formation of new employer startups. We take up this line of research with a focus on the innovation practice and new firms in rural areas using primary survey data on rural establishments. Our research examines the role of innovation by rural entrepreneurs, recognizing that innovation by entrepreneurs is an essential element driving theories of rural economic growth and development. Our initial approach builds on new economic models of entrepreneurship and adapt them to the rural environment, highlighting the factors influencing the adoption of innovations and the link between human resource practices used by the firm. We examine six kinds of innovations that firms can pursue and document the extent of innovations across firms, initial links to the employment decisions by firms, and tease out initial complementarities across the innovations. Firms have documented if in the past three years they developed innovations in six areas: new or improved goods, new or improved services, new methods to manufacture, new methods in logistics, new methods in process support, or new methods in marketing.

Our research uses primary survey data on rural establishments to differentiate firms who have not pursued innovation from those with positive innovation outcomes. We develop empirical measures influencing the decisions that guide our identification of these rural entrepreneurs. The entrepreneurs rely on skills related to innovation and planning ability, access to physical capital and human capital in hiring, and team building skills to develop and use innovation and expand their businesses. A key feature of the model is to link benefits offered by

the firm to innovation policies. We develop a measure of the benefits offered by the firm, a count measure of 6 benefits drawn from the survey. The benefits include health insurance, if the firm offers a retirement plan, a firm-supported plan to pay for professional development, paid maternity leave, employee ownership, and paid time off for volunteering.

Data and Methods:

The data is drawn from the Rural Establishment Innovation Survey (REIS), a nationally representative sample of innovation in rural areas of the United States administered through ERS, USDA. REIS defines innovation as the introduction of new goods, services, or ways of doing business that are valued by consumers. We assess the performance of the firms in developing innovation, examining key characteristics that distinguish firms that have not pursued innovation compared to those who document innovation.

We examine six kinds of innovations that firms can pursue and show the share of firms that report an innovation in each category over the most recent three years of the survey. The firm respond whether in the past three years they developed innovations in six area: new or improved goods, new or improved services, new methods to manufacture, new methods in logistics, new methods in process support, or new methods in marketing.

The share of firms across each innovation exceeds 25 percent with innovations in the service area leading at about 43 percent. Another way to assess the adoption of innovations is the examine the employment effects associated with the innovation. We show the share of employees at the firms that report an innovation in each of the six categories. Innovations in new or improved services are associated with 53 percent of employees across the set of adopting firms. The general pattern across the two summary measures of the adoptions shows that new services and new methods in process support are the two most dominant innovation categories. A new method in logistics is the least frequent or lowest impact innovation in terms of employment

share. The dependent variable in the model will be the number of innovations by the firm over the past 3 years.

Additional information about the innovation variables is discussed in a few tables. The sample consists of 10,154 firms and about 29 percent of the firms report no innovation. A summary of the data reveals that 28 percent of the firms record 1-2 innovation, 35 percent have generated 3-5 innovations, and 8 percent of the firms are maximum innovators recording an innovation in each of the six categories.

Some of the key explanatory variables for the model are shown in Table 3. We include information on the number of employees at the firm including full- and part-time employees, managers and professional employees, and independent contractors along with the age of the business. We will focus this presentation on how human resource management (HRM) practices of the firms are related to innovations. We outline the HRM practices below.

Some common patterns emerge in comparing the firms with positive innovations to those with zero innovations. The firms with innovations show higher levels of almost all explanatory variables. They hire more of each employee type (full- and part-time, managers and professionals, independent contractors) and these firms have generally been in business longer. The last column of Table 3 shows how much higher (on a percentage basis) the variable is for the set of innovators compared to the non-innovating firms. These differences are statistically significant across the innovator and non-innovators.

We develop a measure of the benefits offered by the firm, a count measure of 6 benefits drawn from the survey. The benefits include health insurance, if the firm offers a retirement plan, a firm-supported plan to pay for professional development, paid maternity leave, employee ownership, and paid time off for volunteering.

We see important pattern in the provision of benefits and the relationship with firm innovation. Firms that report zero innovation are much more likely to offer zero of the listed benefits (27 percent of these firms) compared to 11 percent of firms that have some level of innovative activity. Among firms that engage in innovation, 56 percent offer 2 or more benefits compared to 28 percent for the non-innovating firms. The mean number of benefits offered by the zero-innovation firms is 1.97 while the innovating firm land at 2.61 benefits.

We mention two variables that will enter the model and contribute to identification of the model. We extract information from the survey to identify if the original owner and founder of the firm is still with the firm and working. This variable is noted as the original owner and working measure. In initial modelling efforts we treat this as dichotomous but we plan to investigate how long the original owner has been working with the firm as a more finely tuned measure of owner involvement. About 34 percent of innovating firms report an original owner still working and this percentage is 72 percent higher compared to the firms with no innovations.

Another variable assesses if the firm uses profits (or retained earnings) to finance the firm operations and innovations. Among the innovating firm, 72 percent that they finance using profits and again we see a stark comparison with the complementary set of firms. The percentage is 92 percent higher compared to the firms with no innovation as only 38 percent of these firms rely on profits for or financing.

Combining these two variables we form a group where both conditions hold, that the original owner is still with the firm and that the firm uses profits for financing. For convenience we will refer to the dual criterion group when firm meet both conditions. Here we see stark difference in the innovation activities. For the innovating firms, 21 percent of that group falls in this dual category. For the firms that do record an innovation, 56 percent of these firms have both original owners present and working and also use profits as a finance vehicle. The graph below

reinforces that pattern. Innovation across each category is higher (left side panel) for all firms compared to innovation from firms that meet the dual criterion (right side panel).

In turn, the decision to provide benefits to employees is quite different across firms grouped by the dual criterion. One third of the zero innovation firms meeting the dual criterion do not provide any benefits. By contrast only 10 percent of innovating firms in the group do not provide any benefits.

We merge in two new factors that could influence the business environment of our county level data. First, we access gross domestic product (GDP-CA) measures by county developed by the Bureau of Economic Analysis (Panek, Rodriguez, and Baumgardner, 2019). These new measures of gross domestic product (first released in 2019) represent the value of goods and services produced within a county and account for the economic growth and dynamics of the county where the REIS firms are located. A comprehensive measure of the economies of counties, metropolitan statistical areas, and some other local areas. The BEA has noted the county GDP measure can be used to compare the size and growth of county economies across the nation and the statistics will help business owners, county officials, and other policymakers make decisions about allocating resources, spotting growth opportunities, planning investments, and devising economic development strategies."

Second, we access recently developed county level data from the Census Bureau's Business Formation Statistics (BFS) on new business applications. Business Formation Statistics (BFS) are a product of the U.S. Census Bureau developed in research collaboration with economists affiliated with Board of Governors of the Federal Reserve System, Federal Reserve Bank of Atlanta, University of Maryland, and University of Notre Dame as outlined on the website (see, Business Formation Statistics: Methodology, 2024).

Business Formation Statistics (BFS) provide timely and high frequency data on business applications and employer business formations. The two main application series studied are Business Applications (BA) and High-Propensity Business Applications (HBA). BA is the broadest set of business applications, including applications that may result in either new employer or non-employer businesses. We also examine the HBA data that measures the set of high propensity applications that are more likely to transition into a business that plans to hire workers or will be incorporated. The Census Bureau explicitly notes that the data "enhance the ability of researchers, policymakers, analysts, and businesses to assess recent national and local trends in business formation, monitor the state of entrepreneurial activity, and anticipate and respond to shifts in economic conditions."

We use the 10-year average of both the county gross domestic product (GDP-CA) measures and the county business applications, based on the 10 years prior to the survey. Examining the descriptive statistics for these variables we note a distinct pattern. The average county GDP (in counties with innovating firms) is $22.16 million but is actually 12 percent lower compared to the county GDP for counties with no innovating firms. The county GDP for counties that report no innovating firms averages about $25.25 million. We see a similar pattern for the business applications (in thousands). Business applications in counties reporting innovating firms have a 10-year average of 3.44 thousand application and this is 12 percent lower for firms that report no innovation.

Our research examines the link between human resource benefits offered by the firm and innovation. The six benefits are health insurance, if the firm offers a retirement plan, a firm-supported plan to pay for professional development, paid maternity leave, employee ownership, and paid time off for volunteering. The graph below draws out the relationship and motivates our modelling approach. In the top set of bars, we see firm innovations linked to the benefits offered.

The top bar shows how the firms break down in their range of benefits offered and that outcome is linked with the firm's innovations. In top set of three bars, 79 percent of firms offering no benefit also do not record any innovations. By contrast, only 26 percent of the firms that offer the complete set of benefits report no innovation. Another way to view the data is to note which firms achieve maximum innovation. Among firms that offer the most benefits 17 percent report the highest levels of innovation. Only 2 percent of firms with zero benefits have the highest innovation levels.

Figure 3 provides some clarity on the link between innovation and benefits when the size of the firm is also considered. We showed in the table of descriptive statistics that innovative firms make more hires of each employee type. The firms are classified into quantiles by total employment as measured by the sum of the three employee classes. In a first look at size, we can take the smallest firms by employment (the first quartile and the blue bars in each group. For any level of benefits, the smallest firms (blue bars) show the lowest level of innovation. For any level of benefits (moving across the Low, Middle, and High categories), the largest firms (green and yellow bars) report the highest innovations.

Alternatively, we can look at the role of benefits as related to innovation. For the larger firms (green and yellow bars) innovations tend to rise as they offer more benefits. The smallest firms (blue bars) do not show that pattern. These firms may offer more benefits but innovations do not increase.

Econometric Model

We apply the two-part model recognizing that the innovation measure is a mixed discrete-continuous variable. The firms generate positive innovations and there is a significant share of firms with zero innovations. Firms may decide not to innovate and the outcome is recorded as zero, or as a zero-censored variable. This empirical feature supports a two-part model on both

theoretical and statistical reason while suggesting that a single-index model for both outcomes may not be appropriate.

A binary choice model is proposed for the probability of observing a positive innovation. Then, a regression model for the positive innovations is estimated, conditional on a positive level of innovations. The two-part model allows the censoring mechanism that generates zero innovations from firms and the positive innovations to follow different models.

As Bellotti et al. (2015) note, the zeros are typically handled using a model for the probability of a positive outcome:

$$\boldsymbol{\phi}(\mathbf{y} > \mathbf{0}) = \mathbf{Pr}(\mathbf{y} > \mathbf{0} \mid \mathbf{x}) = \mathbf{F}(\mathbf{x}\boldsymbol{\delta})$$

where x is vector of explanatory variables, δ is vector of estimated parameters, and F is the cumulative distribution function of an independent and identically distributed error term. For the positive values, the model is:

$$\boldsymbol{\phi}(\mathbf{y} \mid \mathbf{y} > \mathbf{0}, \mathbf{x}) = \mathbf{g}(\mathbf{x}\boldsymbol{\gamma})$$

where x is vector of explanatory variables, γ is vector of estimated parameters, and g is the density function for y | y > 0. The resulting log-likelihood is

$$\ln\{\boldsymbol{\phi}(\mathbf{y}) = \mathbf{i}(\mathbf{i} = \mathbf{0})\ln\{\mathbf{1} - \mathbf{F}(\mathbf{x}\boldsymbol{\delta})\} + \mathbf{i}(\mathbf{i} > \mathbf{0})[\ln\{\mathbf{F}(\mathbf{x}\boldsymbol{\delta})\} + \ln(\mathbf{x}\boldsymbol{\gamma})$$

Here we see that the γ and δ parameters are additively separable in the log-likelihood contribution for each observation. The models for the zero innovations and the positive innovation can be estimated separately. The overall mean is the product of the expectations from the first and second part of the models:

$$\boldsymbol{E}(\mathbf{y} \mid \mathbf{x}) = \mathbf{Pr}(\mathbf{y} > \mathbf{0} \mid \mathbf{x}) * \mathbf{E}(\mathbf{y} \mid \mathbf{y} > \mathbf{0}, \mathbf{x})$$

We estimate the two-part model with a probit specification for the first part (no innovation vs innovation). The second part for the innovation decision uses a generalized linear model (GLM) with the log link and gamma distribution.

Smith, et al (2015) suggested that the one-part generalized linear models (GLMs) are not appropriate for data with a significant proportion of zero as we observe here. They noted that "one-part GLMs incurred increased bias, lower than nominal coverage, and increased type I error rates in all scenarios with 20 to 40 percent zeros." Recall that our data has about 29 percent of the firms reporting no innovation. An advantage of the two-part models is that they are fairly robust to distribution misspecification in estimating coefficient effects.

In future work we plan to examine the hurdle and zero-inflated models that are proposed to handle excess zeros for count data. The hurdle model has two parts: the first part is a logistic regression to model the probability that a count is zero or a positive integer value, and the second part is a truncated-at-zero distribution to model the number of counts greater than zero (i.e., positive integer numbers). Hilbe (2005) proposed a Poisson-logit hurdle regression for count data that we will examine.

Results

Parameter estimates for the two-part model appear in Tables 4a and 4b. All types of employees contribute to innovation and managers and professionals show the largest marginal impact, followed by full- and part-time employees and the independent contractors. The marginal effects of full- and part-time employees on innovation are higher than the impacts associated with hiring of either managers or contract workers and the differences are statistically significant. Firm age is positively related to innovation.

Our main interest is understanding how the benefits provided by the firm are linked to innovation so we will discuss results presented in Table 4b. The marginal effect of the benefits offered on firm innovation is positive and statistically significant. The marginal effects vary with firm age so we computed the marginal effects across firm ages varying from 4 years to 64 years. When we group business age into quartiles the age value ranges from 4 years in the first quartile to 56 years in the fourth quartile. The marginal effect of benefits on innovation tends to decline with firm age.

The survey develops measures of efforts by the firm to monitor customer satisfaction. Firms are also asked if they have initiatives in place to fix problems based on customer complaints. Among firms with positive innovation, 28 percent affirm that they have both these policies, that is they both monitor customer satisfaction and fix problems if customers complain. Only 8 percent of non-innovating firms have both policies in place. Both variables are statistically significant and positively related to firm innovation. The marginal impacts of the customer satisfaction measures on innovation are not significantly different.

The business applications measure (10-year average of new applications on the county level) is positively related to firm level innovation. BA is the broadest set of business applications, including applications that may result in either new employer or non-employer businesses. We evaluate the marginal effect at the mean of each type of employee to assess if specific hiring plans are most highly correlated with innovation given the county level measure of innovation that the firm faces. The impact of the county innovation is positive and significant. The impacts across each type of employee (full- and part-time, managers and professional, contractors) are not that much different. The results suggest that the innovative potential of the county should be monitored but linking that information to firm decisions on types of employees is a second-level and less impactful decision. In short, firms located in counties with higher

levels of new business applications are more innovative but the effect does not differ by the types of employees hired.

The county gross domestic product (GDP-CA) measures (10-year average) is negatively related to firm level innovation. firm level innovation. Larger counties as measured by the value of goods and services produced within a county tend to have a negative impact on innovation. For larger firms as measured by the total employment at the firm, the negative impact of county size on innovation tends to decline.

On a methodological note, we are able to test if a set of explanatory variables are jointly significant in both parts of the model. We test for the joint significance of the county GDP measure and business application index. The Wald test rejects the null hypothesis that these measures are jointly zero in both equations.

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Table 1. Share of Firms with Innovations[a]

Innovations by Firm	Share of Firms w the Innovation
New or Improved Goods	**29.7%**
New or Improved Services	**42.8%**
New Methods to Manufacture	**27.5%**
New Methods in Logistics	**25.1%**
New Methods in Process Support	**30.2%**
New Methods in Marketing	**32.6%**

[a] Calculations from the ERS Rural Establishment Innovation Survey.

Table 2 Share of Employees by Firms with Innovations[a]

Innovations by Firm	Share of Employees at Adopting Firms
New or Improved Goods	**44.8%**
New or Improved Services	**53.1%**
New Methods to Manufacture	**42.8%**
New Methods in Logistics	**36.4%**
New Methods in Process Support	**45.7%**
New Methods in Marketing	**43.4%**

[a]Calculations from the ERS Rural Establishment Innovation Survey.

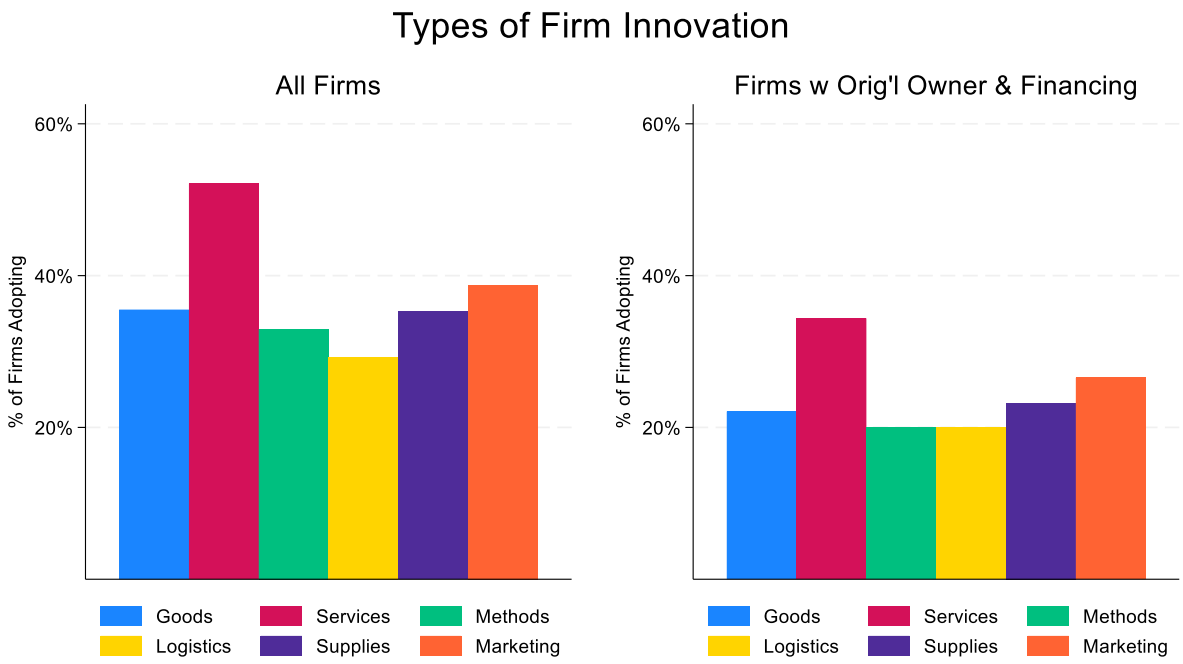
Table 3 Descriptive Statistics for Key Explanatory Variables[a]

FOR FIRMS WITH INNOVATIONS	Mean	StDev	Comparison w Zero Innovation Firms[b]
Full- and part-time employees	30.27	39.01	32%
Managers and professional employees	7.32	6.77	39%
Independent contractors	2.12	3.98	28%
Age of Business	28.7	21.2	4%
Firm uses profits as a source of funding	72.7%	44.5%	92%
Original owner and still employed at firm	33.7%	47.3%	72%
New Business Applications in County (10-year average)	3.44	11.24	-13%
County GDP (10-year average)	22.16	71.96	-12%
Firm documents Good Work Practices	48.0%	50.0%	142%
Firm has Written Position Descriptions	64.4%	47.9%	74%
Firm has Training Documents	45.6%	49.8%	79%
Firm keeps Track of Training	41.3%	49.2%	84%
Firm monitors Customer Satisfaction	39.3%	48.8%	194%
Firm fixes Problems Based on Customer Complaints	54.5%	49.8%	161%
Benefits Offered by Firm (count of 6 benefits)	2.61	1.49	32%
Health Insurance	73.4%	44.2%	23%
Retirement Plan	59.1%	49.2%	25%
Pay for Professional Development	65.3%	47.6%	45%
Paid Maternity Leave	35.7%	47.9%	36%
Employee Ownership	5.9%	23.6%	42%
Paid Time Off for Volunteering	21.5%	41.1%	45%

[a]Calculations from the ERS Rural Establishment Innovation Survey.

[b]The fourth column compares the values for innovating firms to that observed for the firms reporting zero innovation. For example, innovating firms report hiring 32 percent more full- an and part-time employees relative to hires by non-innovators.

Figure 1. Innovations by All Firms[a]



Calculations from the 2014 ERS Rural Establishment Innovation Survey

[a]Left chart shows innovations for all firms.

[b]Right chart shows innovations by firms with original owners still working and also using profits for financing.

Figure 2. The Pattern of Innovation by Benefits Offered and Ownership

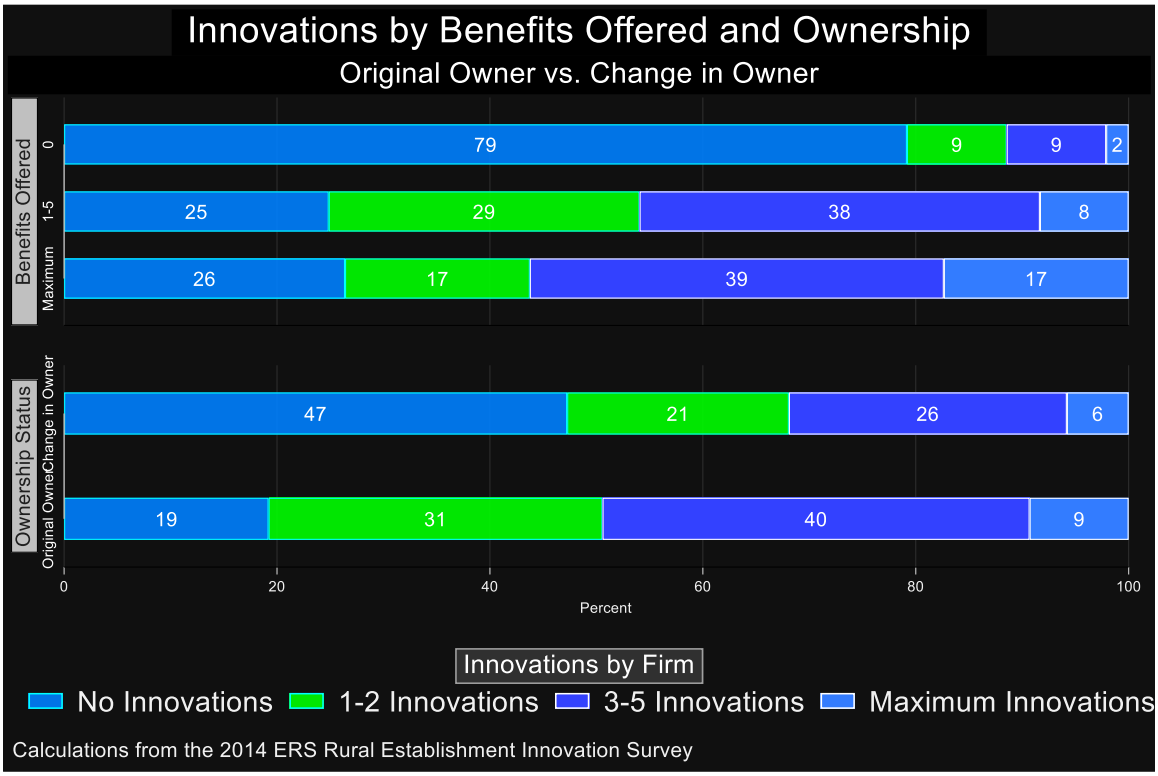
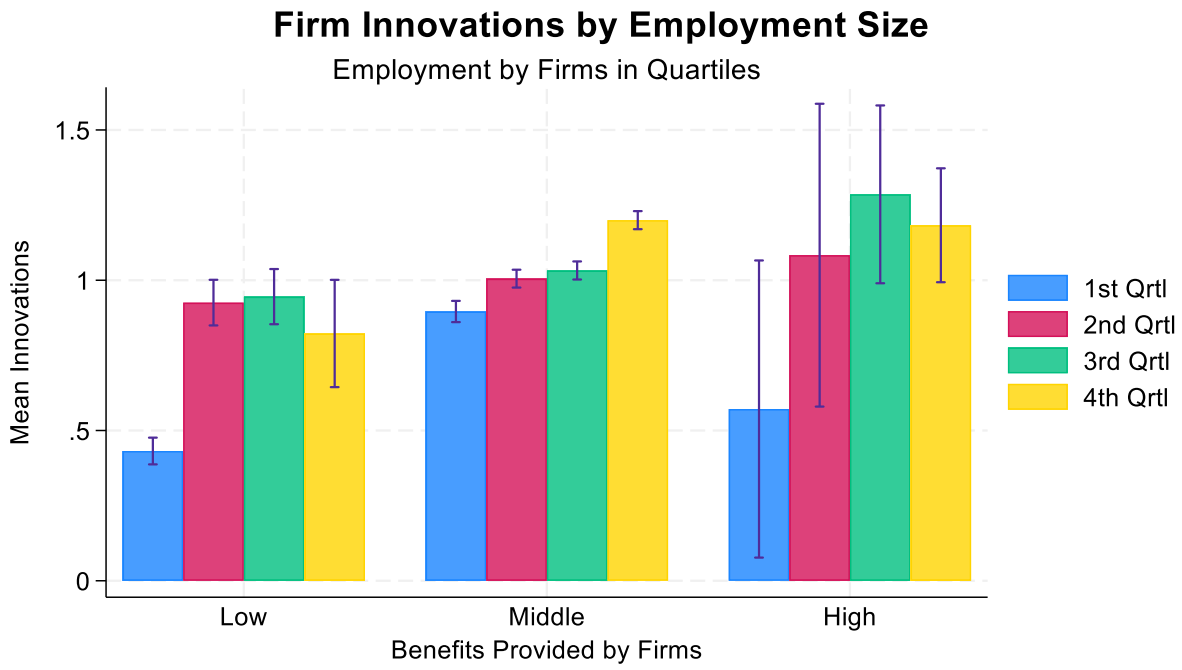


Figure 3. Firm Innovation by Size of Firm



Calculations from the 2014 ERS Rural Establishment Innovation Survey

Table 4a. Selected Parameter Estimates for Decision to Innovate [a, b, c]

Decision to Innovate	Coefficient	Std. err.	z
Full- and part-time employees	0.08	0.02	3.90
Managers and professional employees	0.24	0.03	8.85
Independent contractors	0.06	0.02	3.22
Age of Business	0.80	0.11	7.51
Firm uses profits as a source of funding	0.44	0.03	13.36
Original owner and still employed at firm	0.09	0.04	2.34
New Business Applications in County (10-year average)	0.06	0.04	1.68
County GDP (10-year average)	-0.07	0.04	-1.86

[a] Dependent variable is decision to innovate with zero / one values.
[b] Data from the ERS Rural Establishment Innovation Survey. Industry effects by NAICS codes are omitted from table.
[c] Sample size is 10,154 firms with 2,937 firms reporting no innovation and 7,217 firms showing positive innovations.

Table 4b. Selected Parameter Estimates for Amount of Innovation[a, b, c]

FOR FIRMS WITH INNOVATIONS	Coefficient	Std. err.	z
Full- and part-time employees	0.08	0.02	3.90
Managers and professional employees	0.24	0.03	8.85
Independent contractors	0.06	0.02	3.22
Age of Business	0.80	0.11	7.51
New Business Applications in County (10-year average)	0.04	0.01	2.66
County GDP (10-year average)	-0.03	0.01	-1.97
Firm documents Good Work Practices	0.11	0.01	8.58
Firm has Written Position Descriptions	0.07	0.02	4.50
Firm has Training Documents	0.03	0.03	0.91
Firm keeps Track of Training	0.01	0.03	0.25
Firm monitors Customer Satisfaction	0.10	0.01	8.05
Firm fixes Problems Based on Customer Complaints	0.12	0.01	9.67
Benefits Offered by Firm (count of 6 benefits)	0.01	0.00	3.08

[a] Dependent variable is the count of decisions to innovate.
[b] Data from the ERS Rural Establishment Innovation Survey. Industry effects by NAICS codes are omitted from table.
[c] Sample size is 7,217 firms showing positive innovations across the six innovations: new or improved goods, new or improved services, new methods to manufacture, new methods in logistics, new methods in process support, or new methods in marketing.