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Varieties of innovation and business survival: Does pursuit of incremental or far-ranging innovation make manufacturing establishments more resilient?

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ABSTRACT

The transition from an industrial economy to an innovation economy poses two critical questions for the manufacturing sector in advanced countries. First, given the diffusion of modern manufacturing practices around the world, what level of innovation (incremental, more far-ranging, or radical) is most likely to support a resilient domestic manufacturing sector? Second, are assumed differences in the innovative capacity across space likely to hasten the decline of rural manufacturing? To answer these questions this research combines comprehensive measures of self-reported innovation able to reliably differentiate incremental and more far-ranging innovation with establishment-level data able to examine the geographical distribution of these different innovation strategies. The data used for the analysis includes a two-period panel of manufacturing establishments surveyed in 1996 and 2013 with annual employment data indicating survival in the intervening years. Our findings suggest that long-surviving manufacturing plants overwhelmingly gravitate away from non-innovation strategies toward incremental or more far-ranging innovation orientations. A survival advantage of far-ranging innovation over incremental innovation is observed for standalone firms. We do not identify a difference in the innovation orientations of rural and urban manufacturing establishments.

1. Introduction

The transition from an industrial economy to an innovation economy poses two critical questions for the manufacturing sector in advanced countries. First, given the diffusion of modern manufacturing practices around the world, what level of innovation (incremental, more far-ranging, or radical)[3] is most likely to support a resilient domestic manufacturing sector? If manufacturers in lower wage countries are equally capable of meeting more stringent demands for quality, delivery, and price, then pursuing tactical objectives through incremental innovation may be insufficient to retain high wage manufacturing jobs. Pursuing strategic objectives to meet shifting demands or needs may support a more resilient manufacturing sector but also presupposes a capability for more far-ranging innovation. The contraction of manufacturing employment and enterprises in the U.S. since 2000 provides a compelling backdrop for examining the type of innovation most strongly associated with survival.

The second question addresses expected trends in the geographical distribution of manufacturing within the U.S. Are assumed differences in the innovative capacity across space likely to hasten the decline of rural manufacturing? Operating in less information rich environments, the assumption has been that the best rural manufacturers might excel at incremental innovation but would be disadvantaged in pursuing innovation requiring substantial reconfiguration or development. Does this assumption hold up empirically? The potentially perilous condition of being unable to compete on cost with low wage countries while being unable to compete on innovation with urban manufacturers is not evident in the data (Low and Brown, 2017). This raises the question of what explains the resilience of rural manufacturers relative to their urban peers.

To answer these questions this research combines comprehensive measures of self-reported innovation able to reliably differentiate incremental and more far-ranging innovation with establishment-level data able to examine the geographical distribution of these different innovation strategies. The measures of innovation orientation are derived by combining self-reported innovation questions, as suggested by

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[3] More far-ranging innovation can be thought to correspond with the intermediate categories between incremental and radical innovation suggested by Henderson and Clark (1990). These intermediate categories include "modular innovation" that involves overturning a core component or concept without changing the linkages between components, and "architectural innovation" that involves changes in the linkages between stable core concepts.

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the Oslo Manual (OECD, 2005), with questions on behaviors thought to be strongly correlated with incremental and more far-ranging innovation. Latent class analysis is used to probabilistically assign membership in non-innovator, incremental innovator, and more far-ranging innovator groups. The data used to assess survival includes a two-period panel of manufacturing establishments surveyed in 1996 and 2013 with annual employment data indicating survival in the intervening years. Because the innovation questions were not available in the 1996 survey, innovation orientation is predicted out-of-sample from a 2014 data collection using a 2-sample/2-stage procedure exploiting identical questions appearing in both surveys.

We first review the literature that examines the relationship between innovation and survival, and the geography of innovation regarding the spatial distribution of innovative firms. The derivation of reliable measures of incremental and more far-ranging innovation are then summarized with technical details and validation tests of the resulting measures provided in Appendix 1. A discussion of data and estimation procedures precedes findings of a survival analysis of urban and rural manufacturing establishments from 1996 to 2013. The paper concludes with a discussion of implications of the findings for innovation policy.

2. Theoretical considerations and literature

The effect of firm innovation or a firm's innovation environment on firm exit/survival has received considerable attention in past studies. Most of these studies employ either a variable for innovation measured as innovation input (measures using R&D) or innovation output (patent, patent applications, and counts of innovations). In one of the earliest empirical studies on innovation and firm survival, Hall (1987) links the survival of a firm to its technological capabilities, using R&D and patents as innovation measures. Hall finds that the probability of firm survival increases with the share of accumulated R&D expenditures in the total capital of a firm. She further finds that having patents makes firms somewhat less likely to survive than firms with R&D and no patents.

Audretsch (1991) finds that new-firm survival rates are positively associated with the extent of small-firm innovative activity for longer time periods using the U.S. Small Business Data Base compiled by the U.S. Small Business Administration. Innovative activity is measured as the total number of innovations recorded in 1982 divided by industry employment. However, the relationship is not very strong for shorter time periods. Audretsch (1995) links post-entry performance of new firms to the underlying technological conditions in an industry and finds that it is harder for small firms to survive in industries characterized by an intense innovative environment. On a more positive note, those small firms that do survive such environments exhibit higher growth rates.

Malerba and Orsenigo (1999) present evidence on the effects of innovation on entry and exit using patent data from the European Patent Office for firms in the US, Japan, Germany, UK, France and Italy. They analyze the effects of post-entry innovative behavior of firms (whether they are occasional or persistent) on survival and find descriptive evidence that early entrants who are persistent in innovations survive longer than the later entrants, perhaps due to the competitive advantages held by early entrants. However, they find differing survival rates for different countries in the sample. Pérez and Esteve, 2004 using a Cox proportional hazards model to analyze data from the survey Encuesta sobre Estrategias Empresariales for the period 1990–1999 for Spanish manufacturing firms find that firms that invest in R&D activities experience an exit risk that is 57% lower than firms that do not invest in R&D.

Lin and Huang (2008) study the effects of Schumpeterian technological regimes on Taiwanese manufacturing firm survival. Using three R&D related variables to define Schumpeterian technological regimes (creative destruction or the entrepreneurial regime and creative accumulation or the routinized regime), they find that new firms are more likely to survive under the entrepreneurial regime and this effect is larger within the younger cohorts of firms than within the older ones. Three R&D variables are R&D intensity (defined as the ratio of R&D expenditure to total employment), the R&D share of new firms (defined as the ratio of R&D expenditure by new firms to the total R&D expenditure of the industry as a whole), and the rank correlation coefficient between the R&D intensity and employment.

Buddelmeyer et al. (2009) argue that the existing evidence of a positive relationship between innovative activity and firm survival may be due to a selection effect caused by the degree of uncertainty represented in the innovation proxies used. Using innovation proxies with varying degrees of uncertainty, they present evidence that the degree of uncertainty does in fact affect the pattern of firm survival. They use different innovation indicators to measure the degree of uncertainty in innovation and find differing effects of them on firm survival. For example, they find that while radical innovation capital (measured by number of acquired patents) increases the probability of firm survival, radical innovation investments (measured by patent applications) are associated with a reduction in the probability of survival.

Helmers and Rogers (2010) analyze innovation and the survival of British firms using patents and trademarks as innovation measures and find that firms with higher levels of innovation have a considerably lower probability of exit. However, they find substantial differences in survival probabilities across sectors.

Most studies on innovation and survival focus on the inputs into the innovation process such as R&D expenditure or outputs such as patents and number of innovations. Studies that are closer to the self-reported innovation approach used in the present analysis include Cefis and Marsili (2005, 2006) and Baldwin and Gu (2004). Cefis and Marsili (2005, 2006) study the impact of innovative performance on survival employing different types of innovation, distinguishing between product and process innovation. Using data from the second Community Innovation Survey and the Business Register of the Netherlands for manufacturing firms, Cefis and Marsili (2005) find evidence of an innovation premium, approximately 11% increase in survival time due to 'successful' innovation. Cefis and Marsili (2006) apply a non-parametric approach to the same data. They find that innovation has a positive and significant effect on the probability of firm survival. When estimating the impact of product and process innovation separately they find that process innovation is the characteristic that distinguishes firms with respect to their likelihood to survive. They also demonstrate that this effect is conditional on firm age and size with small and young firms benefitting most from innovation with respect to survival.

Baldwin and Gu (2004) use responses to self-reported innovation questions available in the Canadian Survey of Innovation and Advanced Technologies (SIAT), linked to the Annual Survey of Manufacturers to examine the effect of different types of innovation on productivity growth and establishment survival. They find that process innovation is positively associated with both productivity growth and survival but that product innovation appears to have no impact on productivity and is negatively associated with survival. Although the analysis does not include plant attributes pertaining to geography, the authors do note that the results are consistent with innovators in different stages of the product life cycle, with product innovation dominating in early stages and process innovation occurring later (Klepper, 1996). The geographical implications of the product life cycle are examined by Shearmur (2011) using manufacturing establishment data who finds that major product innovations are most likely to emerge from the largest cities in Quebec, while minor process innovations are least dependent on the assumed agglomeration advantages of cities. Minor product innovations and major process innovations are most likely to occur in the intermediate sized cities separate from the urban core. This distinction suggests that the degree of incremental or substantive innovation may also follow an urban hierarchy gradient in addition to the expectation that process innovations are likely to dominate in rural