

Age, Human Capital and the Geography of Innovation

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Theoretical Framework. We propose instead to distinguish two channels through which the age of employees influences innovative performance. First, we account indirectly for age by accounting for age-heterogeneous human capital and estimating its effect on patenting performance. Second, we consider that apart from age-heterogeneous human capital, there is a direct (or human-capital independent) effect of age on innovative performance. Possible explanations for an independent age-effect are age-dependent differences in the ability to exploit innovation-relevant human capital or age-specific motivation to lead creative ideas to successful inventions.

Data, Model and Estimation. Longitudinal employment data on individual level for Germany allows to specify human capital variables such as formal education, general work experience and organizational tenure. We also dispose of age information, allowing us to account for age-heterogeneity of human capital. However, employment data and patenting data cannot be directly linked on individual or company level. We therefore suggest to use the Griliches-Jaffe (regional) knowledge production framework to analyze the influence of different types of age-specific human capital on aggregate patenting activity in 343 German districts. To our knowledge, we are the first to adopt this aggregate regional perspective of the age-dependency of innovation. Estimation is based on a negative binomial regression model appropriate for count data.

Results. Engineering knowledge and, to a smaller extent, formal academic knowledge loose their innovation-enhancing effect when the labor force grows older: The *share of engineers and technicians* has a significant positive effect, especially for the prime age group 35-49 years and less so for the youngest age group. Engineering knowledge of age group 50+ is, to the contrary, not significant and the parameter estimate close to zero. This suggests a decreasing relevance of 'older' technology-related human capital for innovative output on district level. The effect age-specific share of *academic workers* points into the same direction. Only the share of younger academic workers has a significant positive effect on patenting output (significance levels between 1 and 5%). This reveals the positive effect of 'young', up-to-date academic knowledge whereas 'older', outdated academic knowledge has no significant effect on patenting performance. However, we find no indication for a *negative independent age* effect on aggregate level, so far. *Work experience, sector and firm specific experience* only display significant positive effects for the oldest age group. The average experience level of the prime age group even seems to be negatively related with age. A possible explanation is that high performers are highly mobile, even across industrial sectors.