

## **A Closer Look at Inventive Output - The Role of Age and Career Paths**

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The end of the 19th century was characterized by outstanding and sustainable achievements in the German automobile industry, in particular, in engine construction. In 1876, Otto invented the "Otto Cycle Engine". In 1883, Daimler completed a prototype of the modern gas engine. Only two years later, Benz designed and built the first automobile powered by an "internal combustion engine". Finally, in 1897, Diesel invented the first "diesel fueled internal combustion engine".<sup>1</sup> At the time these inventors made the probably most important inventions of their lives, they were between 39 and 49 years old. This means that these inventions were made at later age, especially, when taking into account a much lower anticipated average life around 1900. This may implicate that great achievements require expert knowledge collected over decades and possibly also experience of life.

Against the background of the aging of the economically active population accompanied by the current opinion of a decreasing productive efficiency with age, it will be interesting to analyze the age-output relationship of German inventors more closely. To do so, this study integrates both inventor related characteristics and external factors that may influence observable inventive output.

This paper suggests using citation counts as an output measure to overcome biases caused by strategic patenting behavior (Hall 2004). Since the number of citations a patent receives is a measure for its quality (Harhoff et al. 1999), citation counts seem to be rather independent of the increasing patenting activity.

This paper moves beyond previous research by combining three data sources. First, it uses survey data on 3,049 German inventors, who hold at least one granted European patent. To trace the inventive output of each inventor over time, the EPOLINE database of the European Patent Office (EPO) was used. In particular, all patent applications with priority dates between 1977 and 1999 that listed one of the 3,049 inventors were extracted from the database. To validate the results of the multivariate analysis, 24 interviews were conducted with R&D managers, inventors, IP managers, and human resource managers in firms active in different industries.

To estimate the relationship between inventive output and age, a fixed effects panel regression will be conducted. To do so, the inventors' patent applications were sorted into groups according to the age of the inventor at the time of the application of the patent. In particular, nine five-year age groups were constructed which represent the time structure of the panel. Then the remaining variables were categorized according to this time structure (i.e., to the nine age groups). To accommodate different career paths of inventors over time, the sample is sub-divided into three groups: inventors who kept on inventing for their whole professional life, inventors who spent at least a major part of their professional life in inventive activity, and finally, inventors who stopped inventing after a short period of time.

Results reveal that the longer inventors remain in R&D, the higher their inventive output. A possible interpretation may be that inventors who remain in R&D get more experienced and consequently increase their output. However, following the statements of the interviewees, it seems more reasonably to assume that the causality runs the other way around, inventors who generate more output stay in R&D, whereas less productive inventors leave R&D for another job, e.g., in sales. Additionally, results show that not taking different career paths of engineers into account leads to an underestimation of the output of older inventors. For instance, inventors who are promoted into management positions are no longer visible in terms of patents or citations, since they may no longer be part of R&D projects.

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<sup>1</sup> See [http://inventors.about.com/od/germaninventors/German\\_inventors.htm](http://inventors.about.com/od/germaninventors/German_inventors.htm); <http://www.dhm.de/lemo/html/biografien/DaimlerGottlieb/>, access on Feb. 13, 2007.