Journal of Economic Behavior & Organization 110 (2015) 45–58

Contents lists available at ScienceDirect

Journal of Economic Behavior & Organization

journal homepage: www.elsevier.com/locate/jebo

Selection and the age – productivity profile. Evidence from chess players☆

Marco Bertoni[a], Giorgio Brunello[a,b,*], Lorenzo Rocco[a]

[a] University of Padova, Italy
[b] IZA

ARTICLE INFO

Article history:
Received 10 May 2014
Received in revised form 3 November 2014
Accepted 18 November 2014
Available online 3 December 2014

JEL classification:
D83, J14, J24

Keywords:
Sample selection
Attrition
Ageing
Productivity
Cognitive abilities

ABSTRACT

We use data on professional chess tournaments to study how endogenous selection affects the relationship between age and mental productivity in a brain-intensive profession. We show that less talented players are more likely to drop out, and that the age-productivity gradient is heterogeneous by ability, making fixed effects estimators inconsistent. Since we do not observe the players who dropped out of chess before the beginning of our sampling period, we cannot exploit the standard Heckman sample selection correction procedure. Therefore, we correct for selection by using an imputation method that repopulates the sample by applying to older cohorts the self-selection patterns observed in younger cohorts. We estimate the age-productivity profile on the repopulated sample using median regressions, and find that median productivity increases by close to 5 percent from initial age (15) to peak age (21.6), and declines substantially after the peak. At age 50, it is about 10 percent lower than at age 15. We compare profiles in the unadjusted and in the repopulated sample and show that failure to adequately address endogenous selection in the former leads to substantially over-estimating productivity at any age relative to initial age.

1. Introduction

There is a broad perception that mental ability declines with age, and not just for humans.[1] Cognitive psychologists have identified two principal components of this ability, that evolve differently over the life cycle: "fluid intelligence", capturing the thinking part of ability, which includes memory, abstract reasoning and executive function; and "crystallized intelligence", which encompasses the role of education and experience (Rohwedder and Willis, 2010). Following rapid development during childhood and adolescence, fluid intelligence starts decreasing from about age 20 while crystallized intelligence increases until middle age and beyond.[2] Unless experience, knowledge, motivation and effort can fully compensate for the decline in fluid ability, productivity is also bound to decline.

☆ The authors are grateful to Guy Michaels, Mario Padula, Roope Uusitalo, Jan Van Ours, Matthias Weiss and to the audiences at seminars in London (LSE), Padova, Turin (EALE) and Venice for comments and suggestions. We also thank Michele Bertoni for technical help with data collection. Financial support from the University of Padova (Grant CPDA093857 – Percorsi Lavorativi e Invecchiamento Attivo) is gratefully acknowledged. All errors are our own.
* Corresponding author at: Department of Economics, University of Padova, via del Santo 33, 35100 Padova, Italy. Tel.: +39 049 8274223.
E-mail address: giorgio.brunello@unipd.it (G. Brunello).
1 See The Economist (2004) and Bloom and Souza-Poza (2013).
2 Schaie (1993) and Schaie et al. (2004) illustrate the results of the Seattle Longitudinal Study, pointing out that fluid abilities – including inductive and deductive reasoning – tend to decline with age earlier than crystallized abilities. The decline is largest for verbal meaning and number skill than for word fluency. There is also evidence that some mental abilities such as social skills or creativity do not necessarily decline with age whereas abilities to perform well and fast under pressure decline. Finkel et al. (2003), use Swedish data and find stability with respect to age for measures of crystallized ability, linear

http://dx.doi.org/10.1016/j.jebo.2014.11.011

In many developed countries, population is ageing. If individual productivity declines with age, overall productivity will also decline, with important macroeconomic implications. In spite of the important implications for modern economies, surprisingly little is known about the relationship between age and individual productivity, and the little that we know is not pointing unambiguously in the same direction.

Several studies have investigated the relationship between *firm or plant – level* productivity and age by estimating production functions augmented with employees' average age. For instance, Hellerstein et al. (1999), use US data and show that productivity somewhat increases with age, and that productivity and earnings rise at the same rate over the life cycle both for prime age workers (aged 35–54) and for older workers (aged 55 and over). In a study of Canadian data, Dostie (2011), finds instead that both wage and productivity profiles are concave, at their highest for the 35–55 age group and diminishing at older ages. In a similar fashion, Cardoso et al. (2011), use administrative longitudinal data for Portugal to estimate the relationship between firm – specific average productivity and age, concluding that productivity increases until age 50–54, and declines afterwards. Finally, Van Ours and Stoeldraijer (2011), use data collected by Statistics Netherlands to match information about individual workers with information about the firm where they are employed. It turns out that their estimates vary with the estimation method, showing upward sloping age – wage profiles when they use dynamic panel data models, and flat profiles when the fixed effects estimator is adopted.

The studies that examine the relationship between age and *individual* productivity are relatively few. Skirbekk (2004), reviews this literature and concludes that productivity follows an inverted U-shaped profile, with significant decreases taking place from around age 50.[3] Van Ours (2009), on the other hand, finds that while physical productivity does decline after age 40, mental productivity – measured by publishing in economics journals – does not decline even after age 50. Finally, Borsch-Supan and Weiss (2007), use data on the production workers of a large German car manufacturer and conclude that productivity does not decline at least up to age 60.[4]

Measuring the effects of age on productivity is difficult. First, it is hard to find reliable measures of individual productivity. Second, in many jobs individual productivity should include also the effects on the productivity of others, either because of knowledge spill-overs or because some jobs involve a relevant team component. Third, the relationship between age and productivity in observed samples is often affected by endogenous selection. If more productive workers are more likely to stay in their jobs, for instance because they retire later (see Myck, 2007), selection may induce a spurious positive correlation between age and productivity.

In this paper, we investigate the effects of endogenous selection on the age-productivity profile by using data on professional chess players. Focusing on chess players has important advantages. First, chess is a brain – intensive activity, which combines fluid abilities (including recalling from memory and abstract reasoning) with crystallized intelligence (that includes cumulated experience and learning). On the one hand, chess players need to be good and fast both at recalling board positions and already seen templates, and at remembering or elaborating the best way to react to them. On the other hand, to do so they have to draw from a large inventory of positions, patterns and moves learned throughout their career (see Gobet et al., 2004; Gobet and Simon, 1996). Second, a quality – adjusted measure of individual productivity can be computed by using wins, draws and losses in professional tournaments, weighting each result with the measured strength of the opponent. Third, chess is a purely individual activity, differently from most professional activities where team work and spill-overs among agents influence individual output. Because of this, our measure of productivity is accurate.[5]

We collect data on all chess tournaments organized by FIDE, the international chess federation, between 2008 and 2011, and on the participants to these tournaments. For each participant, we have information on his ability and that of his opponents as well as on the results of the games he played, that we use to compute individual productivity. Self – selection affects these data in two important ways: first, it influences the composition of players observed at the beginning of the sample period, as many of these players are survivors of a selection process that started well before 2008. Second, there is substantial attrition between 2008 and 2011. When productivity is not separable in terms of age and ability,[6] and there is self-selection, commonly used fixed effects methods fail to deliver consistent estimates of the age-productivity profile.[7]

While standard Heckman correction techniques can be used to correct for attrition during the sample period, they are less suited to address the selection occurring before the observation period starts, simply because we lack the necessary information. To illustrate with an example, our initial sample of players who were active in 2008 includes also individuals aged 30 or older. Assuming that professional chess players start at age 15, dropping out of chess for those aged 30 in 2008 could have happened any time between 1993 and 2007. To capture all potential players aged 30 in 2008, including those

age changes for many cognitive abilities, and a significant acceleration in linear decline after age 65 for measures with a large speed component. The trade-off between age – related decline and skill – related improvement is pointed out by many, including Jastrzembski et al. (2006) and Salthouse (1996).

[3] Recent contributions in this area that use individual productivity data include Weinberg and Galenson (2005) and Castellucci et al. (2011).

[4] Pekkarinen and Uusitalo (2012), look at the population of Finnish blue-collar employees and use piece-rate wages as proxies for output. Their findings indicate that labour productivity stays roughly constant after age 40.

[5] While preparing for chess games may require substantial group-level training, the game itself is purely individual.

[6] Heterogeneous age-productivity profiles are discussed by Dostie (2005) and Buchinsky et al. (2010).

[7] See Göbel and Zwick (2012), for a discussion of estimation methods in this area of research.