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DEMAND FOR OLDER WORKERS: WHAT DO ECONOMISTS THINK? WHAT ARE FIRMS DOING?

Steven G. Allen

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ABSTRACT

The employment rate for workers 55 and over has been increasing across the world for the last decade. This creates opportunities for employers to diversify their workforce and retain valuable knowledge and skills, while at the same time posing the challenge of rising labor costs and blocked opportunities for younger workers. This study summarizes in layperson's terms the economic tradeoffs facing organizations as they design the optimal age structure of employees, as well as surveying recent research on how older workers fit into organizations. Empirical studies show that whereas wage and benefit costs increase with age, there is no conclusive evidence that productivity increases as well. Studies using macroeconomic data find no evidence that older workers block opportunities for the young, but two recent papers using a more disaggregated approach show that firms treat older and younger workers as substitutes. A key challenge facing older workers is the decline over the last 20 years in the odds of becoming a new hire. Although the turnover rate for older workers is much lower than for other age groups, employers have concerns about accommodating their work environment and work schedule preferences. Resume studies show age discrimination also plays a factor, especially for women. The paper concludes with suggestions for future research, including interindustry and international comparisons of microeconomic data on employment by age group and studies that take a close look within organizations that have engaged in innovative activities to hire or retain more older workers.

Steven G. Allen
Jenkins Graduate School of Management
NC State University
2124 Nelson Hall
P.O.Box 7229
Raleigh, NC 27695-7229
steve_allen@ncsu.edu

I. Introduction

Across the world the labor force is getting older. This is resulting from a combination of factors, including increased longevity, lower birth rates and a higher percentage of older workers staying in the labor force.

In the US, the share of the labor force consisting of workers age 55 or older has risen from 12.4 percent in 1998 to 18.0 percent in 2008 and 23.1 percent in 2018. It is projected to rise to 25.2 percent by 2028 (Dubina et al, 2019). This is a consequence of two forces. First, population growth for the 55 and over age group has been much more rapid than for the 16-24 and 25-54 age groups. Second, the labor force participation rate for persons 55 and over has been rising. The rate for those 55 to 64 increased from 59 to 65 percent between 1998 and 2018, whereas the rate for those 65 to 74 rose from 18 to 27 percent over the same period.

There is a hefty economics literature that digs deeply into the factors leading more older people to stay in the labor force longer. Improving health is no doubt one factor. Also, today's labor force is better educated and thus has better earnings opportunities. Coile (2018) provides evidence that adjustments to Social Security have increased work incentives. Her study also points out that the replacement of defined benefit by defined contribution plans has encouraged longer careers. Lastly, there are numerous stories in the popular press that claim more older persons are working because they cannot afford to retire, presumably a reflection of inadequate savings.

Population aging has a macroeconomic impact as well, which has been examined in studies by Acemoglu and Restrepo (2017), Cutler et al (1990), Eggertsson, Lancastre, and Summers (2019), and Poterba (2014). Assuming no change in labor force participation among the elderly, aging results in lower GDP per capita. This can be offset by capital deepening or induced

technological change. For the most part these propositions have been examined with aggregate data for Organisation for Economic Co-Operation and Development (OECD) countries.

While there have been numerous studies of the labor supply and macroeconomic aspects of workforce aging, there has been relatively little research on the labor demand side. Employers have preferences regarding the age mix of their workers, depending at least in part on their customers, their production technology, and their need for business continuity. A neglected question in the economics literature has been how firms have responded to changing demographics and how they are likely to respond in the future. A key employer concern is management of flows of workers of different generations in and out of the organization and across positions within the organization. For example, consider the case of a company that has a relatively large percentage of workers who are 55 and over. On the one hand, the firm faces the risk that many of its older workers will all retire at once, leaving gaps in critical positions and creating a loss of organizational knowledge. On the other hand, there is the possibility that older workers staying longer than expected, leading to blocked promotion opportunities of the next generation and possible turnover among younger workers.

This paper summarizes key elements of the research literature in labor economics that address employer decisions about hiring and retaining older workers. It begins in Section 2 with an overview of the theoretical considerations driving employer choices and summarizes data and empirical studies of the key parameters that can be empirically examined. The primary consideration behind employer demand for older workers are the rates at which compensation costs and productivity change with age. In addition, there is the question of the best mix of employees by age group, which relates to (1) whether workers of different generations are

substitutes or complements for each other and (2) how older workers interact with advanced technology. Empirical evidence regarding these matters is summarized in Section 3.

Another critical consideration is the transaction costs associated with the hiring of older workers. Many firms will be unwilling to hire older workers if they pose more challenges as new hires. One possible concern is that firms do not believe older workers will stay with them very long, making them reluctant to invest in their human capital. Another is that the older workers insist on work schedule and work environment accommodations that make them more costly or less productive. These costs could offset any labor cost of productivity advantage associated with hiring more older workers. Lastly, even if these costs are negligible or nonexistent some employers may believe otherwise and refuse to consider older workers for positions. Of course, there is a fine line between a transactions-cost argument for not hiring or retaining older workers and pure and simple age discrimination. This paper examines the evidence associated with transactions costs and discrimination in Section 4.

Better understanding of these issues will inform decisions made by organizations about future staffing. It also will guide any innovations in public policy designed to encourage firms to hire or retain more older workers. For instance, Clark and Shoven (2019) examine the consequences of creating a "paid-up" status for Social Security and Medicare. The extent to which this would stimulate employer demand for older workers hinges on labor demand parameters. Section 5 discusses directions for future research that could yield deeper insight into how firms have responded to the aging labor force so far and might respond in the future.

II. What economic theory tells us

From an employer's perspective, there are five key economic considerations that govern decisions about hiring older workers. First, there must be alignment between compensation and productivity. This may not be true for each and every worker for every time period, but at some level of aggregation (location, division, company-wide) the value of extra output created must equal labor cost. Second, employers make educational and training investments that lead experienced workers to be more productive than their entry-level counterparts. Third, even if no training is taking place, some companies adopt an upward-sloping profile of earnings over time to encourage work effort and discourage turnover. These latter two factors dictate higher labor costs for older workers, costs that must be offset by higher productivity. Fourth, employers develop strategic human resource plans that take into account the right mix of workers along with the mix of workers with the production process. In situations where jobs are homogeneous, older workers are substitutes for their younger counterparts. In other cases, older workers are complements to younger workers. This will happen when jobs are designed to fit the talents of workers of different age groups, such as younger workers doing physical tasks or tasks that require little experience and older workers doing more complex tasks or tasks requiring experience or judgment. Fifth, strategic human resource plans hinge upon how technology is expected to change over time. In fields undergoing rapid technological change, the question arises as to whether new technologies and older workers will be complements or substitutes.

Labor cost and productivity over a career

Cost and productivity are the two factors at the heart of every economic analysis of firm staffing decisions. In the most stripped down "Principles of Economics" view of the world, all labor is alike, and firms take the cost of labor as given by the market. Firms continue to add

labor until the value created by an extra worker just matches the cost of that worker. But if all workers are alike, then there is no need to be concerned with how wage and productivity levels vary by age or experience.

More realistic models account for worker heterogeneity in ability, education, and training. Gary Becker developed the concept of human capital, a framework encompassing optimization decisions by both workers and employers. Workers decide how much to invest in education, health and training using the same framework that MBAs use to make decisions about investment in new capacity. For instance, in the well-researched literature on educational choice, the prospective college student decides whether the increased earnings associated with college completion are sufficient to offset the cost of tuition, textbooks and earnings loss. Employers simultaneously make decisions about hiring standards. They will prefer to hire MBAs over undergraduates if the salary differential for MBAs is smaller than the productivity differential.

Investment in training is just as important as educational investments in the Becker framework. If firms do not invest, productivity will be a horizontal function of age; wages would equal productivity at every step of the career. More typically firms will make training investments which require firm resources and lost production from the worker while in training. If the skills obtained through the training are marketable to a sufficiently large number of companies (e.g., training in programming languages such as Python, R or SQL), the worker will pay for the training through reduced wages during training. In return the worker will receive a higher salary once trained, reflecting increased productivity. This scenario summarizes what Becker called general training and results in an upward sloping earnings profile over time.

Most training involves a mix of skills, some useful in the broader marketplace and others valuable only at the company where the training is provided. For instance, a business analyst

who learns SQL also will need to learn about various corporate data bases and how to get them to talk to each other. These firm-specific skills dictate sharing training costs between the worker and the firm, as well as a split in the economic returns to training. The worker pays for some of the costs through reduced wages during training and receives some of the returns post-training through higher earnings. Again, the result is a profile where earnings rise over time with the firm. The slope of the profile hinges on the size of the training investment, the associated productivity increase, and the percentage of costs paid by the worker. Once the training is completed, the worker is paid less than his contribution to output but more than the amount that would have been paid in the absence of training.

Age-earnings profiles can be generated in the absence of training investments. If the firm and the employee both expect such a multi-year employment relationship, there are opportunities to adjust the sequencing of pay for mutual benefit. In one such scheme, introduced by Lazear (1979), workers are paid less than their productivity in their initial years and paid more in their final years. Workers who fail to meet expectations in their initial years are dismissed, resulting in a penalty of lost future earnings. With such a payment system in place, productivity increases for two reasons: (1) workers unwilling to exert themselves self-select out and (2) those who are hired have a strong incentive not to slack off and be forced to leave. With higher productivity over the worker's career, career wages correspondingly increase. The pay sequence is set up so that the present value of productivity equals the present value of compensation.

There are risks to each side in such an arrangement. Workers are exposed to the risk of being let go just when they get to the stage where their pay is greater than their productivity. This risk is mitigated somewhat by the firm's concern about a diminished reputation that will limit its

ability to hire in the future. However, there is always the risk that the firm becomes less competitive and needs to reduce staffing.

Firms run the risk that workers will overstay their welcome, collecting more years of premium pay than anticipated in the original bargain. At one time mandatory retirement clauses served as a check on this behavior. Defined benefit pension plans also create strong incentives to leave by a specific age or length of service, although such plans have become increasingly rare in the private sector. The lure of Social Security payments provides an incentive to retire, but this is a universal benefit that is not tied to firm-specific labor contracts.

Relative demand for older workers

So far, we have established that firms will pay older workers more than younger workers either because they are more productive or because the firm has an incentive plan to encourage longer job tenure and higher productivity. Let's turn now to the question of what determines the age structure of a company's workforce taking the age-compensation and age-productivity patterns as given.

Firms make hiring decisions over time based on current and anticipated product and labor market conditions. The age structure of a firm's workforce at any given point in time reflects hiring decisions made in the past and present as well as retention patterns. Firms can end up short of older workers and long on younger workers for a number of reasons, including newness of the firm, rapid growth in recent years, high turnover, or low hiring rates 20 to 30 years ago. The opposite pattern can occur if a firm did a lot of hiring 20 to 30 years ago, had little growth since then, or has high retention.

The firm's age structure also reflects the criteria that are used to make hiring decisions. Although age cannot legally be an explicit factor in a hiring decision, the productivity demands

and training requirements for different jobs will generate a clustering of younger hires for some positions and more experienced hires for others.

Strategically the firm will select the mix of junior and senior employees that maximizes profits. The simplest way to view this decision is to assume that firms make decisions about labor mix separately from decisions about other inputs, such as equipment, materials, software, and structures. In this case, younger and older workers are always substitutes and their usage is dictated by two simple variables: their relative wages and their relative productivity. Firms will hire more younger (older) workers if they are more (less) cost effective.

A more complex, but also more realistic, approach is to recognize that there are complementarities between different types of labor and other inputs. Suppose that the firm has a mix of jobs, some of which involve using the latest hardware and software and others of which involve interfacing with customers. Suppose also that young workers are better than older workers in the information technology arena and that old workers are superior to young workers in customer relations. In this situation it will be the strategic decision of the firm regarding information technology investments and staffing customer relations that drives the total number of jobs and the mix of old and young workers. When the job requirements of old and young workers are fundamentally different, they are more likely to be viewed as complements to each other in the production process than substitutes.

Whether they are or not is an empirical question. As Lazear (1998) points out, younger workers will have an advantage in some dimensions because they have the most recent training. They will bring a lot of general human capital to the table. Older workers general skills may not be as strong, but they will have stronger firm-specific capital. In particular they will know a lot more than younger workers about the firm itself and the markets in which it operates. The two

groups can be complements if they share knowledge. Firms that face rapid technological change or require skills that are acquired through schooling are more likely to tilt toward younger workers. Firms that have intense firm-specific capital investments or idiosyncratic internal operating procedures will tilt toward older workers. Section 3 will review the evidence to date on the complementarity or substitutability between older and younger workers.

A final consideration in the age structure question concerns heterogeneity within age groups. The analysis so far has been based on the assumption that all old workers are alike in terms of productivity. The same assumption applies for younger workers. Any manager with any experience will say that this is a poor assumption. Firms pull various levers (such as promotion, training, or dismissal) to manage the range of acceptable productivity, with an end goal of reducing the length of the lower tail of the performance distribution and retaining the top performers. Both the amount of performance variation and the flexibility the firm has to deal with that variation will drive the decision on age structure.

The variance in productivity within an age group will factor into decisions about a firm's age structure. Fallick, Fleischman and Pingle (2010) show that the variance in wages for men increases with age and that the variance accelerates after age 60. This is consistent with increasing variance in productivity, although the acceleration after age 60 could reflect self-selection into retirement. If the variance in productivity is greater for older workers than younger workers, the result is a larger lower tail that has to be subjected to some form of performance management. One way to make that tail smaller is to actively manage the percentage of older workers on payroll. (In past decades defined benefit pensions would resolve this problem by encouraging most workers to retire.)

Holding the variance constant, the firm's flexibility is also critical. Firms can deal with non-performing new hires fairly easily; they can be reassigned, fail to get raises, or get fired with little collateral damage. To the extent that younger workers tend to dominate the demographics of the newly fired, this reduced heterogeneity translates into higher productivity. As for older workers, employers have to be concerned about the risk of an age discrimination or wrongful termination case, as well as the impact on the esprit de corps of other employees. Recognizing these considerations, firms would be more inclined to have a younger workforce.

III. Empirical evidence

The focus so far has been to summarize how economists think about firm's demand for older workers. Although this unquestionably provides some useful insights for employers, empirical evidence is needed to make informed decisions. Although we can be pretty sure that older workers cost more, the key issue is how much more and whether the cost difference is offset by any productivity difference. One also has to look at data to get any insight into the question of whether older workers are substitutes or complements for younger ones. This section summarizes the empirical evidence on age and productivity, age and compensation, whether older and younger workers are substitutes or complements, and the role of technological change in determining the age structure.

Age and productivity The question of how employee age is related to productivity has been around for eons. It has been approached by a wide range of methods in a wide range of disciplines. Certain biological factors are taken as givens. Over time the body experiences changes in muscle mass, physical strength, and metabolism. Persons become more susceptible to

disease and need more time to recover from injury or stress. Many experience challenges with seeing and hearing.

But how much of an impact does aging have on job performance? If the occupation in question is running back in the National Football League or ballerina in the Bolshoi, the answer is clear – a large impact at a relatively early age. Whether these biological factors matter for most office or production jobs is more difficult to ascertain. One must consider when the decline starts to take place (before or after people in that line of work usually retire), whether it impacts performance at the job in question, and if there are options for accommodation.

Mental capacity and attitudes also have to be considered. The psychology literature on aging and performance focuses on attention, perception and working memory. In their summary of this literature, McDaniel et al (2012) conclude that working memory declines significantly with age, which will impact performance in jobs where new information has to be processed quickly. The attitude of older workers will impact their performance if they become less open to change or less willing to learn new skills.

Some aspects of job performance improve with age. Older workers have more experience, which gives them a memory bank that they can draw upon that younger workers are less likely to possess. This will create value in situations where the knowledge needed for top performance is stable; it will be less valuable in cases where new knowledge is emerging rapidly. With age comes maturity, so many managers believe that older workers are more "dependable, stable, and honest." (McDaniel et al, 2012).

Ultimately the relationship between age and productivity is an empirical question. Research on the relationship between age and productivity has to overcome many barriers to be convincing. Among the greatest challenges are:

1) Objective measures of individual productivity are not available for most occupations.
2) Age is closely tied to work experience and job tenure, both of which have independent effects on productivity.
3) Simple cross-sectional comparisons of productivity by age or age group cut across different generations; one would need to track the same workers over time to purge cohort effects from an analysis.
4) Even when we have good productivity data on a set of employees over multiple years, the data is generated by a self-selection process. As a cohort of workers ages, various members will retire or become disabled. The remaining older workers are likely to be those who have received raises and promotions; their productivity may not be representative of their cohort.

Table 1 summarizes eight studies by economists on how aging in the workforce is related to productivity of individual workers or establishments. I excluded studies that examined a limited scope of professions, such as artists, athletes, or economists. I also excluded studies that rely on subjective measures of productivity, such as annual performance evaluations. These evaluations are rarely standardized to objective criteria and may themselves reflect prejudice against older workers.

Five of the studies rely on matched employee-employer data sets for Austria, Germany, Israel, and the US. They examine the relationship between an output or productivity measure for the entire establishment and the age structure of the establishment, as measured by the percentage of employees in various age brackets. Studies of Germany and Israel find that plants with a larger share of older workers have higher output or productivity. Two studies of the US

find the exact opposite: lower output or productivity in plants with large shares of workers 55 and above. The Austrian study finds no relationship between age and productivity.

One challenge in interpreting these results is that it is hard for the researchers to capture the hiring and retention dynamics over the years that have generated the age structures that are observed at a given point in time. Plant A could have a large percentage of older workers because it has not had many new hires over recent decades. If this has happened because the plant is inefficient or product demand is weak, value added is likely to be low compared to other establishments. Plant B could have a small percentage of older workers because it is in a new plant in high-tech industry. In this case we would see high productivity. Plant C could have a large percentage of older workers because it invests in training and promotes from within, resulting in higher productivity. Plant D could have a small percentage of older workers because the pay is low, the working conditions are unpleasant, and no one sticks around, with low productivity being a necessary byproduct. The US experience may be captured by Plants A and B, whereas the German and Israeli experience may be reflected in Plants C and D.

Another way to approach this issue is to see how productivity is related to changing population trends across different locations. Maestas, Mullen and Powell (2016) examine how labor productivity growth varies across states in relation to growth in the percentage of the population age 60 and over. They match data from the Censuses of Population with data on GDP per state. Their key result is that GDP per capita grows more slowly in states with an aging population, largely because of lower productivity growth (as opposed to slower labor force growth).

The remaining two studies (Borsch-Supan and Weiss, 2016 and Borsch-Supan, Hunkler and Weiss, 2019) focus on employees in a German auto manufacturing plant and a German insurance

company. They have an objective measure of output in each case, error rates in the auto plant and transactions per hour in the insurance office. In the auto plant error rates declined with age up through age 65. The age-productivity profile in the insurance company was flat between the ages of 20 and 60; there were not enough employees above age 60 to generate a precise estimate of productivity after that age.

Having noted the hurdles that any study of how productivity relates to aging has to overcome, it is perhaps no surprise that these eight studies do not point to a clear answer. The plant-based studies are difficult to interpret without an understanding of the forces that lead to differences in age structures across establishments. A similar problem faces studies looking at states, where migration, employment and productivity are all to some degree simultaneously determined. The within-plant studies have a stronger methodological foundation, but it would be hard to consider the case closed based on the findings from two German companies.

But maybe we as economists are asking the wrong question. Perhaps it is manager's *perception* of how aging relates to productivity that matters, as opposed to the actual empirical relationship.

The Society for Human Resource Management (2014) study provides some insights into managerial perceptions of how the productivity of older workers compares to that of their younger counterparts. Managers said that older workers were more productive than younger workers in the following dimensions: more experience (77 percent), more mature/professional (71 percent), stronger work ethic (70 percent), able to serve as mentors (63 percent) and more reliable (59 percent). No questions were asked regarding dimensions in which younger workers were more productive.

Overall, how do managers think the productivity of workers compares by age group? Munnell, Sass and Soto (2006) surveyed 400 private sector employers and found that 56 percent of managers thought that workers 55 and older were more productive than younger workers in white-collar jobs, with another 39 percent saying they were equally productive. For rank-and-file jobs, 41 percent of the respondents said that older workers were more productive than younger workers and another 41 percent said productivity was equal between the two age groups. Bersin and Chamorro-Premuzic (2019) report a Deloitte survey where 10,000 companies were asked whether age was a competitive advantage or competitive disadvantage in their organization. Over two-thirds said it was a disadvantage. The net result is that we have two studies reporting diametrically opposite results on the question.

Age and compensation The age-earnings profile is one of the best-established empirical findings in academic labor economics. The concept, pioneered by Jacob Mincer, is that there is a concave relationship between earnings and age, with a steep initial slope at early career stages followed by a gradual flattening and a decline around age 60. Human capital investments in education and training drive the profile, with large investments at young ages tapering down to zero near career end.

What does the age-earnings profile look like today? Figure 1 demonstrates median earnings for men by five age groups and eight education groups from the March 2018 Annual Social and Economic supplement to the Current Population Survey. Earnings of 35 to 44 year-olds are 13 to 65 percent higher than earnings of 25 to 34 year-olds, with the larger differentials prevailing for the groups with the most education. Earnings continue to increase for 45 to 54 year-old workers across every educational category. After age 54, there is more of a mixed pattern. Workers age 55 to 64 with bachelor's degrees earn less than those age 45 to 54, whereas earnings

of workers without college degrees increase slightly over this age range. Earnings decline after age 65 for all but two educational groups: doctorates and professional graduate degrees.

Taken at face value, the profile indicates that labor costs rise with age up to a certain point and then fall. Subsequent research has challenged this interpretation for the following reasons:

- Earnings equal compensation per hour times hours worked, so if workers either cut back on hours there will be a decline in earnings without necessarily any change in the cost per hour for the employer.
- The age-earnings profile typically is estimated over workers from different birth cohorts. All but a handful of estimates fail to trace the same worker over time.
- Self-selection kicks in as workers near retirement. As some members in a cohort exit the labor force, the skill composition of the remaining labor force changes.
- Earnings data, whether they come from Social Security records or phone interviews, ignore other elements of compensation, including bonuses, pensions, health insurance and other employee benefits.

Ruggles and Ruggles (1974) were among the first to focus on earnings growth for the same individual over time. They found that if you switch from cross-section data that includes multiple cohorts to longitudinal data, the earnings pattern for older workers over time changes considerably. In the longitudinal data, earnings continue to grow up until age 65 whereas earnings start to decline at earlier ages in the cross-section data. Johnson and Neumark (1996) examine longitudinal data for men from the 1970s and 1980s and focus on the profile of hourly wages instead of earnings. They find that wages peak at age 62. Wages fall three to five percent in later years, mainly because many of the older men age 62 or over have simultaneously started Social Security and moved into a part-time job at a lower wage. They could not find evidence of

falling wages after age 62 for men who did not receive Social Security. A subsequent study by Casanova (2013) finds a similar pattern in the 1990s and 2000s for men working full-time.

Employee benefit costs represent as much as a quarter of compensation costs at many firms and are not included in the earnings studies cited here. Health insurance costs increase with age. Research by the Kaiser Family Foundation (2019) shows that firms with 35 percent or more employees age 50 or over pay group premiums for a covered individual that are 8.5 percent higher than for firms with fewer than 35 percent. Tabulations by Value Penguin (2019) provide additional insight from the market for health insurance for individuals. These premiums are a close-to-linear function of age until 45 or 50, at which point they become convex. Premiums for those in their 60s are three times larger than for those in their 20s.

Pension cost patterns vary between defined benefit and defined contribution plans. In the former, the firm's pension obligation accelerates (in terms of cost per hour) as workers near retirement age. Defined contribution costs are typically a flat percentage of payroll at all age ranges. In either case the cost per worker increases with age.

Vacation pay tends to increase with tenure in most organizations, so the cost of this benefit per hour also will rise with age. According to the BLS National Compensation Survey, the mean number of vacation days for an employee with one year of service is 11 days. This rises to 15 for employees with five years of service and rises further to 17 for those with 10 years and 20 for those with 20 or more years.

Overall when taking wage and salary costs along with employee benefits, the evidence indicates that the cost of labor per unit of time worked steadily increases with age up until the early to mid 60s, at which point it either levels off or increases slightly because of employee benefits.

Older workers – complements or substitutes for younger workers? The discussion so far has been framed in the fairly simple terms of how productivity of older workers matches up with their compensation. Let's turn now to a broader question regarding organizational design. Companies have a variety of jobs and need to find the employees who are the right matches for those positions. Some firms have a large number of relatively unskilled positions and are comfortable staffing them with entry-level personnel. In this scenario all types of labor are substitutes for each other; in particular, older workers are substitutes for younger workers. Others have internal labor markets where some hiring is done at entry-level, but most positions are filled by internal promotion. Now things get more complicated because older workers are needed to develop the younger ones, making them complements. But if the older workers start staying with employers longer by delaying retirement, there could be a reduction in entry-level openings making them substitutes.

Formally, the question of whether two inputs are substitutes or complements hinges on the nature of the production function. In any situation where there are only two variable inputs, then they have to be substitutes for each other. This would be the case in situations where capital is fixed (or nonexistent) and the other two inputs are older and younger workers. In cases where there are three or more inputs, there are more possible options. Suppose the three inputs are younger workers, older workers and information technology. In this case it is possible for younger and older workers to be complements to each other, but each type of worker could be substitutes for information technology. It is equally possible that younger workers could be IT complements, with older workers being substitutes for younger workers and IT.

What does the evidence say about whether older workers are substitutes or complements? Below two types of studies will be summarized: studies using macroeconomic data that look for

tradeoffs in employment rates by age and studies that directly estimate labor demand parameters associated with substitutability or complementarity from data on firms.

Macroeconomic approaches Gruber and Milligan (2010) use aggregate time series data for the US from 1962 through 2007 to determine how changes in the labor force participation rate of the elderly (defined as 55 to 64) are related to changes in labor force participation and unemployment of young and middle-aged workers. They find "no consistent evidence" that the rising labor force participation of older persons in recent years has crowded young or middle-aged persons out of the labor market. Munnell and Wu (2012) build upon this analysis by breaking down similar data by state and year for 1977 through 2011. They find no evidence of older workers crowding out younger ones.

Examining trends across multiple countries is another way of approaching this question. Kalwij, Kapteyn and De Vos (2010) examine data on 22 OECD countries from 1960-2008 to determine whether there have been tradeoffs in employment between older workers and either younger or middle-aged workers. They find no evidence that the young and old are substitutes and some suggestive evidence that the two are complements.

Direct estimation of labor demand parameters Hamermesh (1993) summarized a handful of studies that were done in the 1970s and 1980s that estimated production relationships with labor broken into two or more age groups. These studies show that younger and older workers tend to be substitutes for each other. Hamermesh (2001) argues that it is doubtful that these studies have much to tell us about today's labor market tradeoffs. Today's labor force has a much higher level of education and has a much higher percentage of women. It is also doubtful whether the methodologies of these earlier studies would pass muster with journal referees today. To identify a labor demand relationship, there needs to be a clearly exogenous change in the size of

the labor force (or labor cost) accompanied by a credible instrumental variable that can be used to measure that change. Most of these studies would not pass that test.

Two very recent studies attempt to directly estimate whether older and young are substitutes or complements. Bovini and Paradisi (2019) examine whether the 2012 Italian pension reforms that delayed the age of full retirement had an impact on the labor market outcomes of other age groups. The delay in retirement age varied by age, gender and years of contributions to the pension system. As a result the number of persons eligible for full retirement benefits changed in each firm. Bovini and Paradisi examine how the resulting delays in retirement across firms were related to layoffs and new hires of the young and middle-aged. They find that layoffs increase across all age groups in firms with more delayed retirements, with the increase in layoffs being greatest among the middle-aged (35-54) and older (55 and up). New hires of young and middle-aged workers decrease in firms with more delayed retirements. Their overall conclusion is that delayed retirement of older workers had an adverse impact on their younger counterparts.

Mohnen (2019) looks at how job opportunities for younger workers change when more older workers delay retirement, using data on US commuting zones from 1980 to 2017. To identify his model, he uses the change in the employment/population ratio for workers 55 and above that would be expected given the initial age distribution in a zone. This is a weighted average of the national retirement rates by age, with the age weights varying across zones. He finds delayed retirement to be associated with no overall impact on the youth (22-30) employment rate, accompanied by an increase in the odds of part-time employment and a decrease in the odds of full-time employment. Further, youths in areas with more delayed retirees are more likely to be

in low-skill occupations and less likely to be in high-skill occupations. Wages of young workers fall by three percent with each percentage point increase in the 55+ employment rate.

The upshot from these two studies is that delayed retirement among older workers is having an adverse impact on the job market prospects of the young. The impact is on jobs in the Italian evidence, whereas the impact in the US is less on employment and more on job quality.

Older workers and technology The last dimension of labor demand for older workers that will be considered here is the role of changing technology. No matter whether older workers are complements or substitutes with capital at a given point in time, employer demand for their services also will be driven by how adaptable they are to change. For instance older workers might have been complements to the latest technology in the 1980s when the latest technology amounted to a Lotus 123 spreadsheet, but they may or may not be today when the latest technology is machine learning and artificial intelligence.

What impact does technological change have on the relative demand for older workers? Pulling from the discussion above on age and productivity, there are clearly cases where new technologies offset some of the performance limitations associated with the aging process. Robots reduce the physical demands of manufacturing production jobs; search engines augment human memory. On the other hand, some aspects of the latest technologies we see today provide challenges to older workers, as noted by Thompson and Mayhorn (2012). In particular they note issues arising from technology design (especially on small mobile devices) and social norms associated with technology (older workers use email, younger workers text).

In a simple human capital model, employers *and* workers have less incentive to invest in new skills as they get closer to retirement, simply because the payoff period for any new investment keeps getting shorter and shorter. This would imply less demand for older workers in fields

undergoing rapid change. But in practice technological change seems to be most rapid in the same industries over time, so there is likely to be a sorting of workers across employers based on their adaptability to change. Bartel and Sicherman (1993) argue that if these tech-savvy workers have lower training costs, that would lead to continued training investment and longer careers.

Only recently have we seen an attempt to formally model how employers adjust the age mix of the workforce in response to changing technology. Acemoglu and Restrepo (2019) posit that automation is generated by the needs of an aging society. With the ratio of older to middle-aged workers rising, they argue that automation increases the productivity of older workers, who specialize in nonproduction services. This offsets the declining supply of middle-aged workers who specialize in production tasks. Empirically they find a strong correlation between expected aging and robot adoption for 52 countries between 1993 and 2014.

To determine how rising use of robots impacts employment across different age groups, they use data on US commuting zones. In the commuting zones with the largest increase in robotics deployment, wages and employment decrease the most among middle-aged (35 to 54) workers. Wages and employment decrease to a smaller extent among workers age 55 to 64 and do not change at all among workers 65 and over. This implies that robots are complements for older workers and substitutes for younger ones. Ramey (2017) in her comments at a conference where an earlier version of this paper was presented offers an alternate interpretation: robotics are mainly being used to economize on labor costs. She shows that robots are concentrated in industries where there are (1) high wage premiums and (2) greater opportunities for human-robot substitution.

IV. Labor market frictions facing older workers

Although labor cost, productivity and age structure optimization are the fundamental factors driving employer demand for older workers, it would be remiss to ignore additional challenges that are associated with their employment. Labor markets are not like financial or commodity markets that match supply and demand in real time. It takes weeks or months to match prospective workers with job openings. Some aspects of the hiring and job search process work very differently across age groups. In this section the focus will be on how long older workers are expected to stay on the job, how much of an accommodation do employers need to make to provide them with work-life balance, and how much of a challenge do they face because of employer discrimination.

Expected job duration Imagine an employer sizing up two applicants for a position that are identical in every respect except one – their age. Applicant A is 30 years old and Applicant B is 60. From a purely economic perspective, age could become a determining factor in the hiring decision if age is believed to be highly correlated with the odds the worker will stay with the firm *and* the firm has sizable hiring and training costs. The return on human capital investments declines with job duration, so if the expectation is that the 60-year-old will retire relatively soon, the profitability of hiring the older applicant diminishes. On the other hand, younger workers have historically had higher turnover than other age groups, so this could push the decision in favor of the older applicant. In jobs where there are negligible hiring and training costs, age should make little difference in the hiring decision.

Figure 2 displays labor turnover rates by age group for the US from 2014 through 2018, as reported in Quarterly Workforce Indicators. Younger workers have by far the highest turnover rates. The rate for those 21 and under is near 25 percent. The rate for 22 to 24-year-olds varies

between 15 and 19 percent, while the rate for 25 to 34-year-olds stays close to 11 to 12 percent. The rates for workers in older age brackets are much more tightly bunched, with the highest rates of eight to nine percent for those age 35 to 44 and the lowest rates of five to six percent for those 55 to 64. Workers 65 and over had turnover rates between seven and eight percent.

This evidence overwhelmingly indicates that older workers overall are less likely to leave their job. These are absolute probabilities indicating the overall turnover rates for all workers in a given age group, including the most recently hired as well as those who have been around for decades. Further work will be required to tabulate the conditional probabilities that a newly hired person age 55 to 64 will stay longer than a newly hired person age 25 to 34.

Accommodations for older workers Even if older workers are just as or more likely to stay with a firm as younger workers with the same skill set, this does not mean that employer preferences will be neutral by age group. Recent surveys by Society for Human Resource Management (2016) and Clark et al (2019) have shown that many firms have yet to react at all to the changing demographics of the labor force. Based on responses from 1,913 human resource professionals to SHRM's email survey, 36 percent were "beginning to examine internal policies and management practices to address this change." Another 20 percent have decided that "no changes in our policies or practices are necessary," whereas 32 percent were either unaware or just becoming aware of the change. There is a recognition that labor force aging will become a bigger issue in the years ahead. Although 47 percent see the issue as a crisis, problem or potential problem for their organization one to two years out, a much higher 72 percent see it as an issue 11 to 20 years out.

Clark et al's (2019) survey of employers conducted by William Towers Watson shows more concern about employees staying too long as opposed to leaving too early. Over the next five

years 47 percent say employees leaving sooner than desired will be a challenge to some extent or to a very great extent, as compared to 72 percent who say employees staying longer than desired will be a challenge. Between two-thirds and three-fourths of the companies in this survey expect to encounter these challenges with delayed retirement: blocked promotions, misalignment of desired workforce structure, increased wage and salary costs, increased benefits costs, and ineffective succession planning.

For those employers who want to retain a larger percentage of their older workers, there is an additional challenge: many of them expect some additional accommodation to either offset the impact of aging on their productivity or allow them to meet changing family or personal commitments. Two recent studies demonstrate age-related differences in demand for certain job amenities. Maestas et al (2018) find that workers 62 and over have a greater willingness to pay in terms of reduced salary (relative to their younger counterparts) for job amenities such as setting their own schedule, moderating physical activity, paid time off, and working by themselves. Hudomeit et al (2019) examine how job characteristics influence the decision to continue working. They found that flexible work hours, job stress, physical and mental job demands, the ability to telecommute and commuting times were all related to retirement expectations.

Employers are aware of these employee preferences, but many have difficulty responding to them. SHRM (2016) found that 54 percent of organizations do not actively recruit older workers. Between 40 and 50 percent of the firms say they do not have the ability to offer flexibility in work location, job responsibilities, and work schedules. Only three to four percent of the firms had a formal strategy to recruit or retain more older workers.

Clark et al (2019) find collaborating evidence, albeit from a more positive perspective. They find modest proportions of employers in 2018 offering shorter hours (20 percent), part-year employment (27 percent), modified working conditions (36 percent), additional training (40 percent), job alterations with reduced responsibilities (30 percent), and consulting opportunities (49 percent) to some older workers on a case-by-case basis. They find very little interest in formal phased retirement programs.

These survey results indicate there is a mismatch between the job expectations of older workers and the firms that might hire or retain them. In many ways this is reflective of the overall tendency to have one-size-fits-all personnel policies in organizations, especially in the realms of work scheduling and job responsibilities.

Age discrimination The popular press regularly reports on the struggles that older workers have finding jobs. It shows up plainly in the unemployment statistics, where the length of their periods of joblessness far surpasses that of younger age groups. It shows up as well in countless anecdotes of older workers who ace the phone screen and then get rejected once their grey hair is revealed in the face-to-face interview.

Proving age discrimination in economic terms is more challenging. Many studies attempt to show discrimination against women or minorities by demonstrating that the group in question has lower earnings, controlling for other factors related to productivity or working conditions. Since older workers make more money than their younger workers, this methodology will, if anything, "prove" reverse age discrimination against the young. Some of the age-productivity studies surveyed earlier were motivated by a desire to compare age-earnings to age-productivity profiles. Again, since the evidence on age and productivity is mixed and the age-earnings

linkage is quite strong, this approach would again demonstrate that it is the young, not the old, that are discrimination victims.

Audit or correspondence studies attempt to gauge age discrimination by sending out job applications. Audit studies involve actual face-to-face contact whereas correspondence studies involve sending resumes to companies. Age-related differences in callback rates or interview success indicate whether there is age discrimination. Resumes are designed so that clusters of applicants are identical in all respects except age. The resumes are sent to job postings that are representative of the types of jobs that workers from a range of age groups would apply, such as sales or administrative assistants. One methodological challenge associated with this approach is that age and experience are closely related in most cases. What can be learned by comparing a 60-year-old with the same education and work experience as a 20-year-old?

All of the six audit or correspondence studies surveyed by Neumark (2018) find evidence of lower callback rates for resumes associated with older workers. These studies examine data from the 1990s, 2000s and 2010s; five of the six examine US firms whereas the sixth looks at firms in the European Union. The two most recent studies (Neumark, Burn and Button (2019) and Farber, Silverman and von Wachter (2017)) find strong evidence of age discrimination against women. For instance, Neumark, Burn and Button (2019) found that the callback rate for women applying for administrative assistant jobs in the 64-66 age group was 7.6 percent, well below the rate of 14.4 percent for the 29-31 age group.

Overall this evidence indicates that age discrimination is a hurdle that many older persons seeking a new position must face. Facing lower odds of even obtaining the chance to interview for a position, some older applicants could very well become discouraged and terminate their job search.

Getting called in for a job interview is just the first step in the hiring process, so one must be careful in how one interprets these results. The party that screens the resumes, whether machine or person, is not the party making the hiring decision. Algorithms or underlings that screen out a higher percentage of older applicants could be offset by hiring managers who are age-neutral or even biased toward hiring older applicants. Of course, it is equally possible that hiring managers may be even more biased against older applicants. The correspondence studies also are unable to address possible age-related differences in pay or working conditions among new hires.

V. Directions for Future Research

The following picture has emerged thus far about employer preferences for hiring and retaining older workers. Employers will expect to pay, on average, more for older workers both in terms of wage or salary compensation and employee benefits. In return they would expect greater productivity. Yet there is no evidence that older workers collectively are more productive than their younger counterparts. The evidence regarding whether older workers are substitutes or complements for younger workers and whether older workers fit well with organizations with changing technology is equally inconclusive.

From a transactions cost perspective, the raw data indicate one competitive advantage for hiring older workers: they have a much lower turnover rate. On the other hand, the accommodations desired by many older workers such as scheduling flexibility and workplace adjustments are costly to employers and will inhibit some older workers from staying in the labor force. Age discrimination is another barrier to employment of older workers as the audit and correspondence studies show.

Looking ahead over the next 10 years, persons age 55 and over will become a larger share of the labor force. How will firms react to the changing demographics? Will they come up with policies to encourage their older workers to delay the date at which they separate from the firm? Will they change their hiring practices to take advantage of the growing pool of older workers?

Let's begin with a snapshot of trends over the last 20 years. Figures 3 and 4 report long term employment rates and hiring rates respectively for workers 55 and over from 1996 through 2018, as reported by the Bureau of Labor Statistics in its biannual reports on job tenure.

The picture for long term employment in Figure 3 shows shorter job durations for men and longer job durations for women. Among men 55 to 64, the percentage who have been with their employer 20 years or more has decreased from around 35 percent in the late 1990s to about 30 percent over the last 10 years. The rate for men 65 and over was the same in 1996 as in 2018, but it should be kept in mind that the number of employed men in this age group is well below the number of men 55 to 64. Overall a smaller proportion of older men have been with the same employer for 20 years or more.

Women 55 and over are more likely to be in long-term jobs in the 2010s than they were in the 1990s and 2000s. The rate for women 55 to 64 rose from 22-23 percent in the late 1990s to 25-26 percent in the 2010s; there was a larger increase for women 65 plus over the same period from 22-24 percent to 27-28 percent.

The odds of a person 55 and over being in a new job are much lower than for younger workers, as shown in Table 2. Among women 55 and over, 8.9 percent have been with their current employer 12 months or less. The percentage of men with new jobs is 9.5 percent for those 55 to 64 and 7.9 percent for those 65 and over. In contrast workers under 35 have new job holding rates that are three to eight times higher.

Despite the recent rise in labor force participation for older workers, the percentage of them in new jobs has fallen by a sizable amount over the last 20 years, as shown in Figure 4. The decline in new job holding has been modest for those 55 to 64, dropping from 11 to 8.9 percent for women and from 10.3 to 9.5 percent for men. Among those 65 and over, the decline has been more sizable, dropping from 12.2 to 7.9 percent for men and from 13.9 to 8.9 percent for women. In a nutshell, the odds of an older worker showing up in a new job have never been especially high, but they have become considerably lower in the last 20 years.

These data patterns have a clear implication for future research on how firms are reacting to the aging labor force – that research will need to focus on employee retention. In what situations have firms adjusted their internal age structure to match the changing age profile of the labor force? When older workers stay with a firm longer, do they keep doing the same type of job? What happens to their work hours, both in terms of weekly work schedule and number of weeks worked? Is there evidence that younger workers face blocked promotion opportunities and, if so, has this led to exit behavior?

One way in which economic research can provide insights into these questions is to make interindustry comparisons over the last 20 years. Table 3 reports the percentage of employees 55 and over for selected industries in 2018 and shows that this percentage is widely dispersed. Across all industries 23 percent of all workers were 55 and over. In the leisure and hospitality sector, only 14 percent are 55 and over; in funeral homes, the rate is 54 percent. The rate for each industry reflects a broad range of factors, including growth patterns of output, retention rates by age, customer preferences, and job qualifications.

Table 4 reports how the interindustry age structure has changed between when BLS began publishing employment by age and by industry in 2011 and the most recent year available 2018.

Overall the percentage of workers 55 and over rose from 20.6 to 23.3 percent, an increase of 2.7 percentage points. The increase was largest in agriculture, mining, construction, manufacturing, wholesale trade and finance. It was much more modest in information and education and health. As noted in Section 2, changes in the age structure of a firm or an industry can arise from a number of factors, including retention rates, output growth, and shocks from imports or technological change. Data on workforce demographics can be matched with data on output, capital and indicators of technological change to learn more about where demand for older workers has been growing. This line of research also will need to consider how relative wages of younger and older workers have adjusted to the increased labor force participation of older workers, although establishing lines of causality will be a challenge.

International comparisons represent another approach that could be fruitful in gaining insights about how firms react to an aging labor force. Table 5 reports the employment-population ratio for 55 to 64-year-old men for ten selected OECD countries, including the US, for 2000 and 2018. The countries were selected either because there were sizable increases in their employment-population ratio over this period or because their employment-population ratio in 2000 was higher than that of the US. In the US the employment-population ratio increased from 66 to 69 percent. Denmark, Korea, New Zealand or Sweden all had ratios reasonably close to the US in 2000 but witnessed much larger increases. For instance, the ratio rose from 64 to 75 percent in Denmark and 68 to 84 percent in New Zealand. OECD (2018, 2019b) provide further insights into aggregate trends for older workers in different countries. The challenge in future research would be to take a more disaggregated approach to determine the underlying choices made by firms within selected countries where there has been significant growth in the employment-population ratio of workers 55 and over.

The key question posed by these aggregate patterns is what adjustments were made by firms in countries such as Denmark or New Zealand that resulted in the higher employment rates for older men. Did older men delay retirement, or did they find new jobs? What happened to their hours worked? Did they stay in the same type of jobs or did they make occupational changes? What happened to job prospects for younger workers in the countries with the largest jumps in employment-population ratios of older workers?

Another path for researchers to consider is careful internal examination of organizations that have made changes in their personnel policies that influence the hiring or retention of older workers. Clark et al (2019) show that many organizations have implemented or are considering implementation of policies such as shorter hours, part-year employment or reduced responsibilities for older workers. Much could be learned by taking deep dives within the firms that have changed policies in one or more of these arenas. There are clear challenges in conducting such studies, including identifying an organization making a policy change, building enough trust with that organization to obtain access to data, and persuading the organization to roll out any policy innovation in such a way that empirical results will reflect causality instead of correlation. Right now firms considering making changes in these areas are proverbially flying in the dark; careful research on firms that have actually made these changes would be highly illuminating.

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Table 1. Age-productivity studies

Citation	Data	Dependent variable	Level of observation	Results
Hellerstein and Neumark (1995)	Matched employee-employer data, Israel	Output per worker-year	Establishment	Productivity is higher in plants with a larger share of workers age 55 and over
Hellerstein, Neumark and Troske (1999)	Matched employee-employer data, USA	Value added	Establishment	Plants with a larger share of workers 55+ have lower output than those with smaller shares
Haltiwanger, Lane and Spletzer (2007)	Matched employee-employer data, USA	Sales per employee	Establishment	Productivity lower in plants with large shares of workers 55+
Gobel and Zwick (2009)	Matched employee-employer data, Germany	Value added	Establishment	Output rises with age through 50-55 and does not change significantly afterwards
Mahlberg et al, (2013)	Matched employee-employer data, Austria	Value added per employee	Establishment	Labor productivity is unrelated to share of workers 50 and over
Maestas, Mullen and Powell (2016)	Census of Population matched with GDP by state	Growth in GDP per worker	US states	GDP per worker grows more slowly in states with growing 60+ population
Borsch-Supan and Weiss (2016)	Individuals in auto manufacturing plant, Germany	Error rate	Employee	Worker productivity increased with age up to age 65
Borsch-Supan, Hunkler and Weiss (2019)	Individuals in insurance company, Germany	Transactions per person hour	Employee	No differences in productivity by age group

Table 2. Percentage of workers who have been with their current employer 12 months or less, by age group and gender, January 2018

	Men	Women
16 and over	21.8	22.8
16 to 19	72.9	75.1
20 to 24	52.2	55.0
25 to 34	27.2	28.4
35 to 44	16.2	18.1
45 to 54	12.2	11.6
55 to 64	9.5	8.9
65 and over	7.9	8.9

Source: US Bureau of Labor Statistics (2018)

Table 3. Percentage of workers 55 and over, selected industries, 2018

All industries	23
Leisure and hospitality	14
Computer systems design and related services	16
Information	20
Retail trade	21
Construction	22
Professional and business services	23
Education and health services	24
Manufacturing	25
Financial services	26
Public administration	26
Transportation and utilities	26
Wholesale trade	26
Management, scientific, and technical consulting services	28
Real estate	33
Legal services	34
Agriculture	38
Membership associations and organizations	36
Funeral homes, and cemeteries and crematories	54

Source: US Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey, https://www.bls.gov/cps/lfcharacteristics.htm

Table 4. Percent of workers 55 and over by industry, 2011 to 2018

Industry	Percent in 2011	Percent in 2018	Change 2011-2018
All industries	20.6	23.3	2.7
Agriculture, forestry, fishing, and hunting	34.0	38.2	4.2
Mining, quarrying, and oil and gas extraction	18.4	22.1	3.7
Construction	16.8	21.7	4.9
Durable goods manufacturing	21.2	25.7	4.5
Nondurable goods manufacturing	19.1	23.0	3.9
Wholesale trade	21.4	26.4	5.0
Retail trade	18.6	21.2	2.6
Transportation and utilities	23.9	26.3	2.4
Information	17.8	19.5	1.7
Financial activities	22.3	25.9	3.6
Professional and business services	20.0	23.2	3.2
Education and health services	23.3	24.0	0.7
Leisure and hospitality	11.9	14.1	2.2
Other services	24.2	27.0	2.8
Public administration	23.1	26.1	3.0

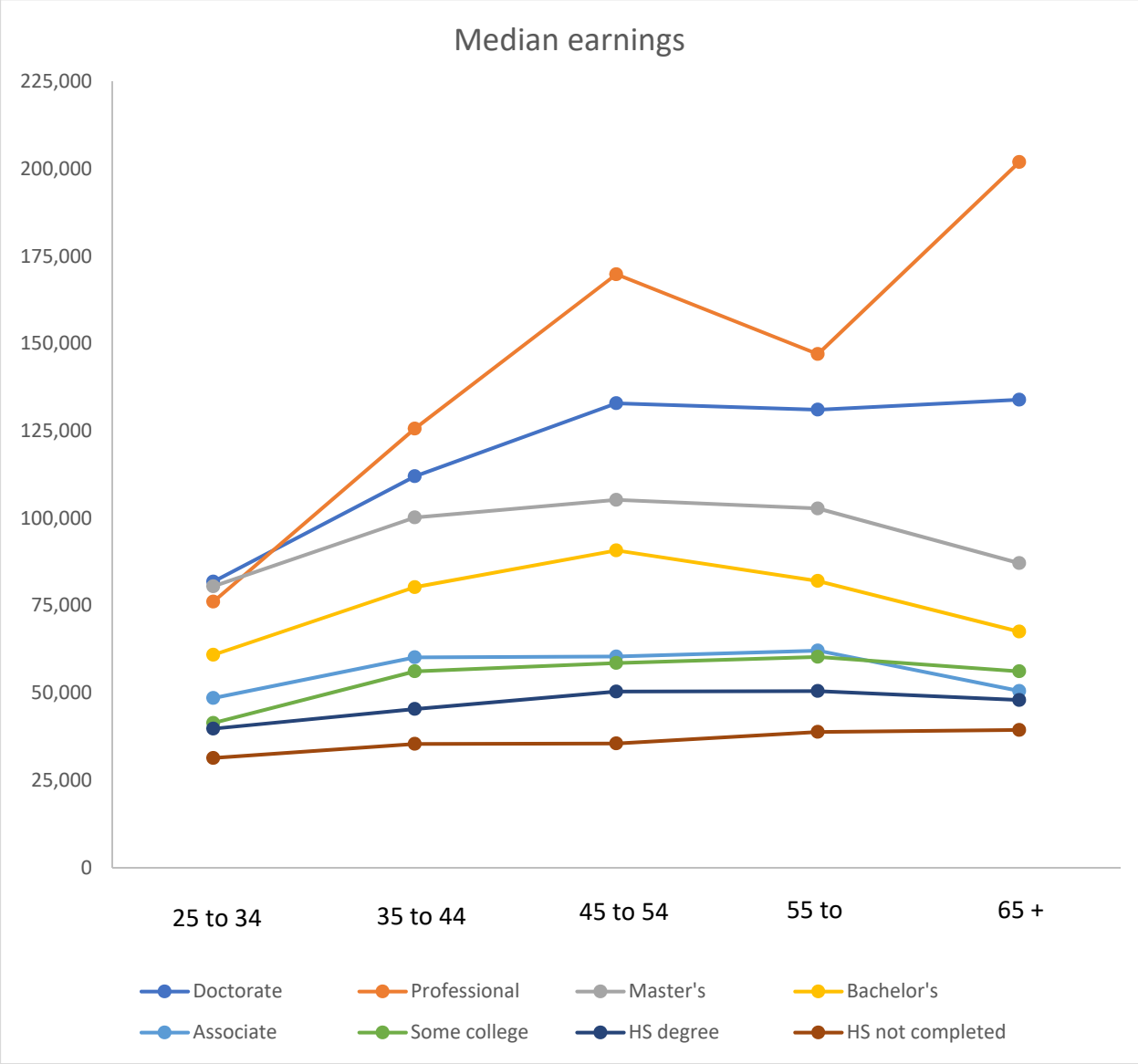
Source: US Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey, https://www.bls.gov/cps/lfcharacteristics.htm

Table 5. Employment-population ratio for men 55 to 64 in selected OECD countries, 2000 and 2018

Year	2000	2018
United States	65.7	69.1
Israel	56.9	73.7
Denmark	64.1	74.9
Norway	73.1	76.1
Germany	46.4	76.1
Korea	68.6	79.4
Sweden	67.7	80.2
Chile	70.6	83.4
New Zealand	67.9	84.1
Japan	78.4	86.3

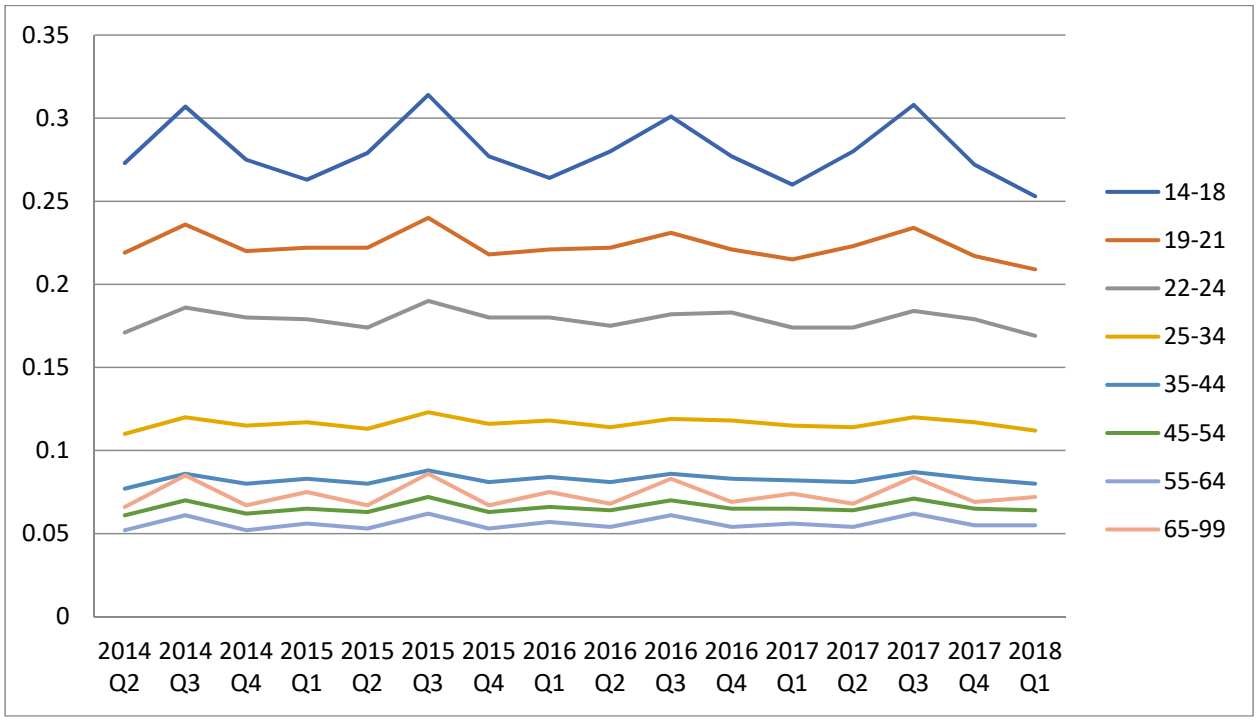
Source: OECD (2019a)

Figure 1. Age-earnings profiles by education



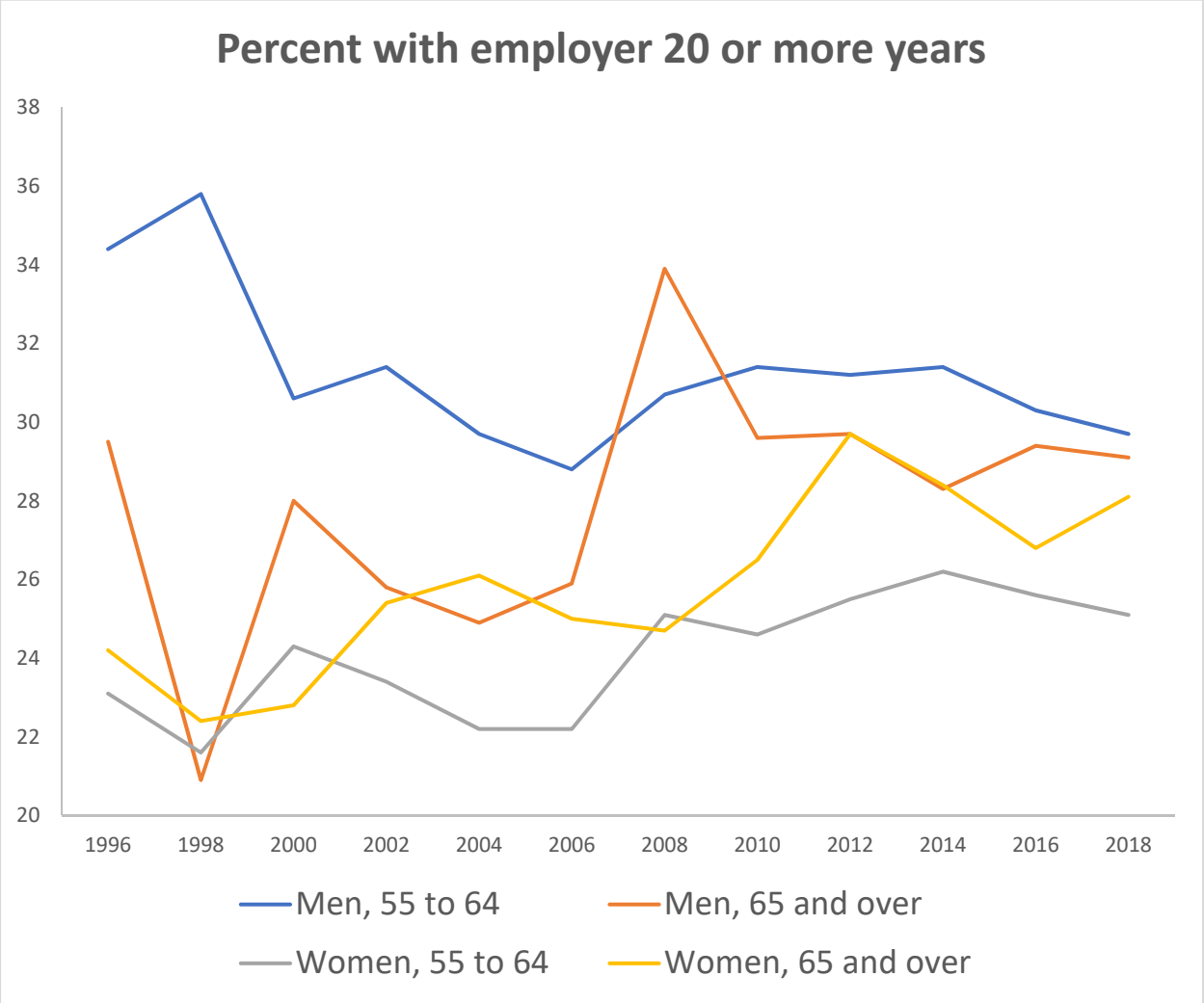
Source: Current Population Survey Annual Social and Economic Supplement, https://www.census.gov/data/tables/time-series/demo/income-poverty/cps-pinc/pinc-03.2018.html

Figure 2. Labor turnover probability, by age, 2014-2018



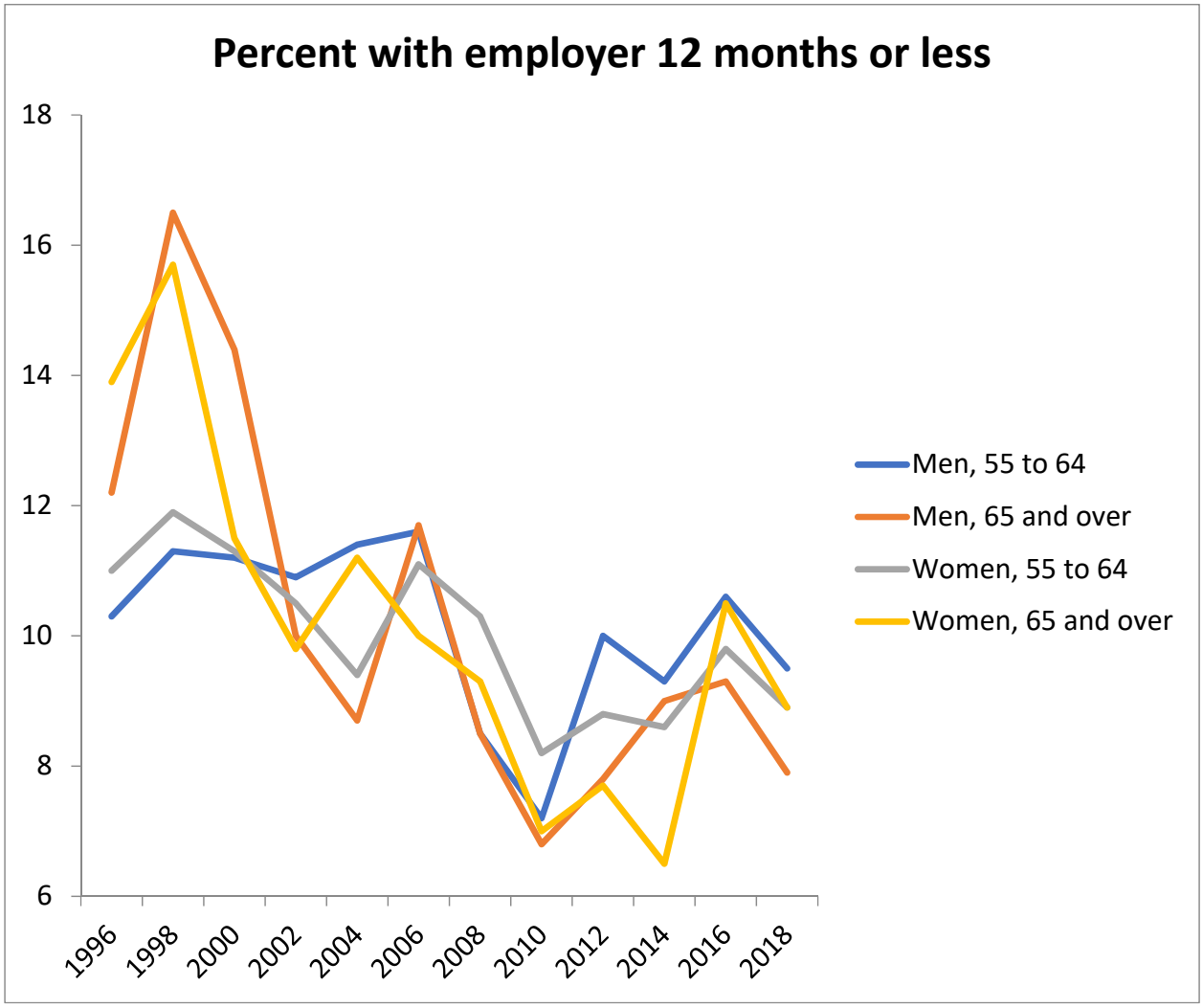
Source: Quarterly Workforce Indicators, https://qwiexplorer.ces.census.gov/static/explore.html#x=0&g=0

Figure 3. Retention rates for workers 55 and over, by gender, 1996-2018



Source: US Bureau of Labor Statistics, Employee Tenure biannual series

Figure 4. Hiring rates for workers 55 and over, by gender, 1996-2018



Source: US Bureau of Labor Statistics, Employee Tenure biannual series