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Increased productivity efforts yield few rewards in the knowledge economy

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ABSTRACT

Population aging is reducing access to knowledge workers even as they are becoming more important to economic growth. Thus far, corporations and governments alike have made the intuitive yet untested assumption that working the existing workforce harder and longer can alleviate the economic fallout. This is based on the 'success' similar efforts have previously seen in production industries characterized by physical inputs. Our study provides evidence that these successes may not carry over to industries, such as transportation that are reliant on intellectual skill. It is shown that meeting productivity goals by increasing the job demands of knowledge workers, specifically air traffic controllers, compromises the provision of new kinds of value added. Furthermore, it is demonstrated for the first time that increasing job duration exacerbates the effects of job demand on human performance. Coping with staffing shortages by asking that knowledge workers simply 'do more' may impede rather than stimulate economic growth.

1. Introduction

In the coming decades, many forces will shape our economy and our society, but in all likelihood none will have as pervasive an effect as population aging (Bernake, 2006). The forces behind this phenomenon are simple: people are living longer and having fewer children (Vaupel et al., 1998). While concerns over this demographic shift have predominantly focused on its impact on intergenerational social support systems (Cliquet and Nizamuddin, 1999), equally important is the question of how population aging affects the wealth of nations (Börsch-Supan, 2008). National wealth (expressed here as total output per capita) is a product of labor force size and output per worker (i.e., average labor productivity). From a macroeconomic perspective, population aging reduces the size of the labor force as a share of total population (Börsch-Supan, 2008). Unless this reduction is compensated for by a rise in aggregate productivity, national output will decline (Börsch-Supan, 2008; Prskawetz et al., 2008).

Labor market institutions, particularly in the transportation sector, are responding to these shortages by raising existing workforce output requirements (McKinsey Global Institute, 2015; Manyika et al., 2015). Although research suggests these efforts may be impeded by human work capacity limits (Holman et al., 2008; Shepard and Clifton, 2000; Thomas and Raynar, 1997), they have historically been embraced, even in the absence of workforce shortages, as a means of minimizing labor costs. Even if an overworked employee is less productive than a well-rested substitute, one person working a hundred hours a week costs the employer less than two people working fifty hours each (Surowiecki, 2014). Thus far, these cost effi-

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ciencies have largely been observed in production-related industries (e.g., manufacturing, construction) where occupational tasks follow precise, well-understood procedures (Autor et al., 2003).

As technology has improved in quality and declined in price, such occupational tasks have been increasingly automated (Autor and Price, 2013), prompting a transition in advanced industrial countries away from a manufacturing-based economy characterized by physical inputs, to a services-driven economy reliant on intellectual inputs (Powell and Snellman, 2004). This transition has boosted demand for non-production workers capable of performing tasks that, due to their abstract nature, do not lend themselves to computerization (Bresnahan, 1997; Carnevale and Smith, 2013) nor benefit from the adoption of 'best practices,' two frequently espoused solutions to workforce shortages (McKinsey Global Institute, 2015; Manyika et al., 2015). Characteristic of professional and technical occupations, workers who are most adept to abstract tasks typically possess high levels of analytic capability and creativity (Autor et al., 2003) and the relative scarcity of these workers is reflected by the high wages they command. The transition also means that workforce productivity is now being evaluated against more complex competitive requirements because unlike the production sector which measures its output by quantity of units produced and increases its production by raising output, non-production sector output is measured by how well inputs are utilized to provide new kinds of value added (Järvinen et al., 1996; Li and Prescott, 2009). In an economy driven by knowledge, raising productivity entails providing a range of higher quality services that meet customer expectations (Li and Prescott, 2009).

The surprising lack of research that examines the productivity of non-production workers (Wacker et al., 2006) means that the question of whether or not a contracting workforce caused by population aging can meet these expectations remains unanswered. As the knowledge economy elevates the social influence and economic power of non-production related occupations (Powell and Snellman, 2004), the need to address this question is pressing.

In the present study, we do so by exploring how increased productivity efforts impact the provision of *service expectations* that reflect the requirements of the knowledge economy. Air traffic control (ATC) was selected as a knowledge-based occupation within the non-production sector (i.e. aviation). Characterized by soaring service demand amid labor shortages and a reliance on analytic skills and creativity to solve complex problems, ATC has transitioned from a historical focus on the provision of air safety alone, to one that emphasizes new kinds of value added (Air Traffic Services Performance Focus Group, 1999). Value here represents a balance between the number of work actions taken (input) that ultimately emerge as a cost to the population, and the provision of a more diverse range of services (output) that go beyond safety.

Unlike previous studies that have focused exclusively on labor hours (subsequently referred to as job duration) as the sole moderator of productivity (Krelle, 1983; Wacker et al., 2006), the ratio of work required to time available (subsequently referred to as job demand) is also considered. This variable has received little attention in the economic realm (Holman et al., 2008; Shepard and Clifton, 2000; Thomas and Raynar, 1997) and its inclusion as a productivity moderator affords (a) consideration of fluctuations in service demand by the population, and (b) differentiation between the impact of meeting this demand by working longer versus working harder. Two groups of controllers completed a simulation exercise that required a complex and realistic sequence of tasks to be executed. The scenario consisted of a single 33-min long subscenario that was replicated five times to create an occupational 'shift' lasting 165 min. This ensured job duration effects could be equitably compared over time. Job demand was manipulated across controller groups by varying the amount of intervention (high or low) required to manage the scenario. Productivity was assessed by measuring the number of work actions executed against a range of identified qualitative outputs generated by those actions.

2. Method

2.1. Domain selection rationale

Aviation is an example of a non-production industry, as it does not generate goods/products that can be evaluated in terms of production units, but rather offers a service whose provision is dependent on the expertise of knowledge workers. The industry faces acute labor shortages, the consequences of which are likely to be profound given its role as a critical supply chain facilitator (Pearce, 2013; World Economic Forum, 2013). ATC is a key system enabler, its importance reflected by the disproportionately high wages controllers receive relative to other industry-wide professions (Bureau of Labor Statistics, 2015). The occupation requires controllers to coordinate air traffic movement by continuously formulating new actions, updating them on the basis of current awareness (National Research Council, 1997), and applying creative solutions to solve complex situational problems.

2.2. Research subjects

Forty-two licensed air traffic controllers were recruited as subjects, being randomly assigned to one of two groups. Group one was between the ages of 27 and 56 years (mean = 42.5), and had an experience range of between 1.5 and 30 years (mean = 19). The second group ranged in age from between 27 to 54 years (mean = 43), and had an experience range of between 5 and 33 years (mean = 19).