# OPTIMAL
# TALENT
# MANAGEMENT
## OF THE ACQUISITION WORKFORCE
# IN RESPONSE TO COVID-19:
# DYNAMIC PROGRAMMING APPROACH

*Tom Ahn and Amilcar A. Menichini*

As the economic impact of the COVID-19 pandemic lingers, with the speed of recovery still uncertain, the state of the civilian labor market will impact the public sector. Specifically, the relatively stable and insulated jobs in the Department of Defense (DoD) are expected to be perceived as more attractive for the near future. This implies changes in DoD worker quit behavior that present both a challenge and an opportunity for the DoD leadership in retaining high-quality, experienced talent. The authors use a unique panel dataset of DoD civilian acquisition workers and a dynamic programming approach to simulate the impact of the pandemic on employee retention rates under a variety of recovery scenarios. Their findings posit that workers will choose not to leave the DoD while the civilian sector suffers

from the impact of the pandemic. This allows leadership to more easily retain experienced workers. However, once the civilian sector has recovered enough, these same workers quit at an accelerated rate, making gains in talent only temporary. These results imply that while the DoD can take short-run advantage of negative shocks to the civilian sector to retain and attract high-quality employees, long-run retention will be achieved through more fundamental reforms to personnel policy that make DoD jobs more attractive, no matter the state of the civilian labor market.

The initial impact of the COVID-19 pandemic on the U.S. civilian labor market was massive, with the unemployment rate spiking to 15% in May 2020. While most world economies contracted in 2020, there is some consensus among economists of a relatively robust recovery in the near future, with average global economic growth projected to be about 5.5% in 2021 (International Monetary Fund, 2021). In the United States, the unemployment rate has already recovered partway since the nadir. However, the trajectory of recovery remains unclear, depending on a host of public health programs, government stimulus, and the macroeconomic environment.
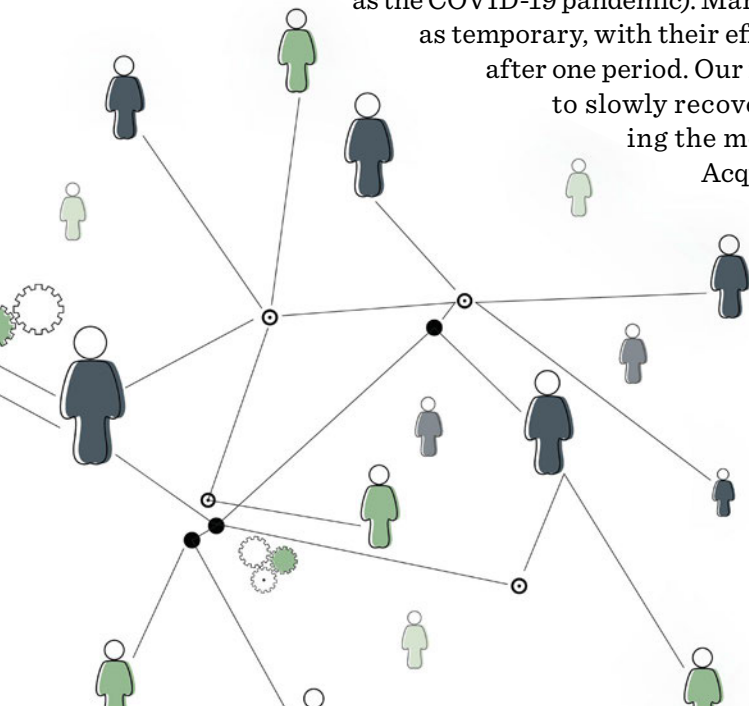
While the civilian labor market has seen extraordinary swings in employment numbers, the government sector has been somewhat immune to the short-term effects of the pandemic. We examine the potential impacts of the gyrations and continuing uncertainty in the civilian labor market on the labor market decisions of public-sector employees, focusing on the civilian Defense Acquisition Workforce in the Department of Defense (DoD). Historically, senior DoD leadership has been concerned with losing qualified senior civilian workers to the private sector. However, the labor market impact of COVID-19 may present a pressing need to adjust personnel policy, as well as an opportunity to leverage the stability of DoD positions to compete against the draw of more lucrative salaries at private firms.

We solve a dynamic programming model of worker retention behavior, where long-lasting shocks in the civilian labor market are explicitly modeled. Retention behavior refers to the employee's decision to remain on the job to which currently assigned (i.e., Defense Acquisition Workforce, as defined in this article) from one period to the next. By shocks, we mean sudden, unpredictable events that affect the civilian labor market. Shocks in principle can be positive (such as unanticipated government stimulus) or negative (such as the COVID-19 pandemic). Many researchers model such shocks as temporary, with their effects on the economy dissipating after one period. Our model allows for negative shocks to slowly recover through time. After calibrating the model parameters to the Defense Acquisition Workforce using a unique panel administrative personnel dataset that tracks the civilian DoD labor force over the span of 30 years, we simulate civilian-side labor market shocks that correspond to economic recoveries of varying speeds and forecast the retention behavior of the workforce.

We find that a persistent negative shock to the civilian sector (plus insulation of the government/DoD labor market from the shock)—in our case, the COVID-19 pandemic—leads workers to devalue jobs in the private sector in the short-run and remain in the government sector for a longer period of time. Depending on the severity and persistence of the shock, it may take more than a decade for workers to return to valuing civilian jobs as they did before the pandemic. This relative increase in attractiveness of government jobs is only temporary, however, and workers accelerate their exit from the government sector into the private sector once the economic recovery is well underway. That is, the retention rate when the economy recovers turns out to be lower than the rate that would have prevailed had the global pandemic not occurred.

> **While the civilian labor market has seen extraordinary swings in employment numbers, the government sector has been somewhat immune to the short-term effects of the pandemic.**

The sections that follow review the relevant literature and describe in more detail the labor market impact of COVID-19 on the private sector and the long-run career trajectories of the typical Defense Acquisition Workforce employee. Further discussion explains the dynamic programming model, describes the data, and calibrates the model parameters. Final discussion considers potential COVID-19 scenarios, projects behavior of the workforce under differing scenarios of economic recovery, and states our conclusions.

## Literature Review

Employee retention has been studied extensively in the personnel economics literature. Most studies have been theoretic in nature or have focused on the private sector due to data availability (Barron et al., 2006; Fallick et al., 2006; Gibbons & Katz, 1991; Lazear, 1986; Wilson, 1969; among many others). One strand of the literature examines retention issues in the DoD, focusing on active-duty soldiers and officers at inflection points in their careers, such as the end of the first Service obligation or promotion (Goldberg, 2001; Warner, 1995). Others study the impact of reenlistment bonuses (Hattiangadi et al., 2004), civilian sector options (Fullerton, 2003), and nonmonetary job characteristics (Golding & Gregory, 2002).

Our article complements the literature on retention issues in the Defense Acquisition Workforce. Guo et al. (2014) and Ahn and Menichini (2021) investigated the demographic factors associated with higher Defense Acquisition Workforce employee retention, such as performance ratings and education. Focusing on retention strategies, Schwartz et al. (2016) analyzed the pay flexibilities authorized by Congress and the Office of Personnel Management to enhance retention of talented Defense Acquisition Workforce personnel. Alternatively, Kotzian (2009) proposed organizational culture and leadership style as effective strategies to increase retention in the long-run. In line with Kotzian, Jenkins (2009) suggested that, instead of monetary benefits, workplace satisfaction and organizational commitment should be the focus of the leadership to achieve highly qualified employee retention. Dobriansky (2009) noted the stability of government positions as a draw for workers compared to the private sector.
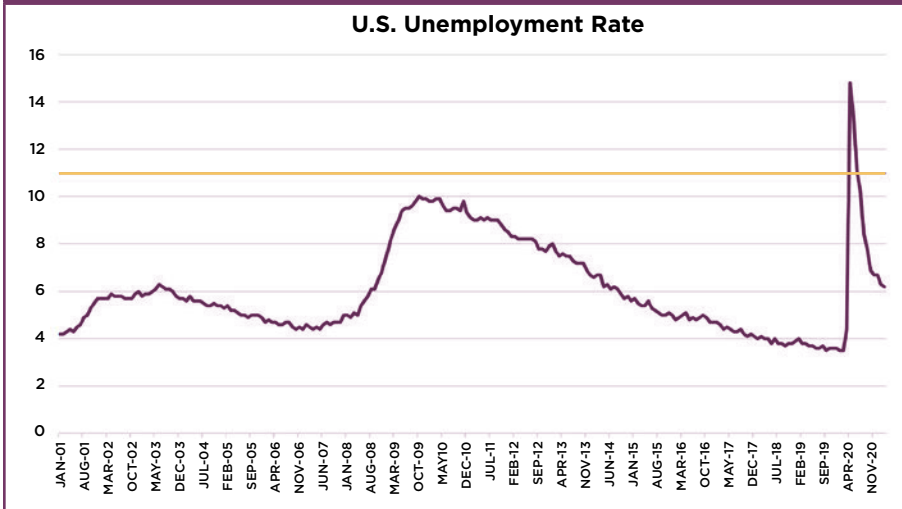


Our article is also related to the literature using the Dynamic Retention Model (DRM) to study employee stay/leave decisions in the government sector. For instance, Asch et al. (2013) used the DRM to analyze how policy changes affect retention decisions during the transition period between the old and the new regulations (e.g., impact of changes in retirement policy).

## The Impact on Unemployment Arising from Covid-19

The short-run impact of COVID-19 has been extraordinary, with the nation's unemployment rate spiking to almost 15% from near historical lows (3.5%) in 2 months. As Figure 1 shows, even during the Great Recession, the nation's unemployment rate peaked at 10.6%. As a further reference, we added a yellow line in Figure 1 showing the previously recorded all-time high in monthly unemployment rate from the U.S. Bureau of Labor Statistics, which was about 11% at the end of 1982. The Congressional
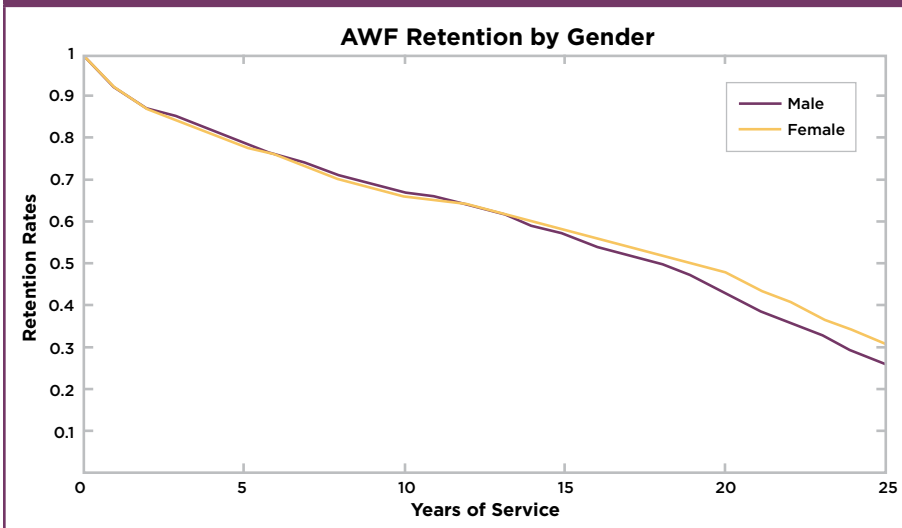
Budget Office (CBO) projects that the U.S. economy will grow 4.6% in 2021, after contracting 3.5% in 2020. These are significantly upwardly revised estimates from its report in July 2020, when the CBO projected a growth rate of 4%. Correspondingly, employment has recovered sharply since May 2020 (CBO, 2021)

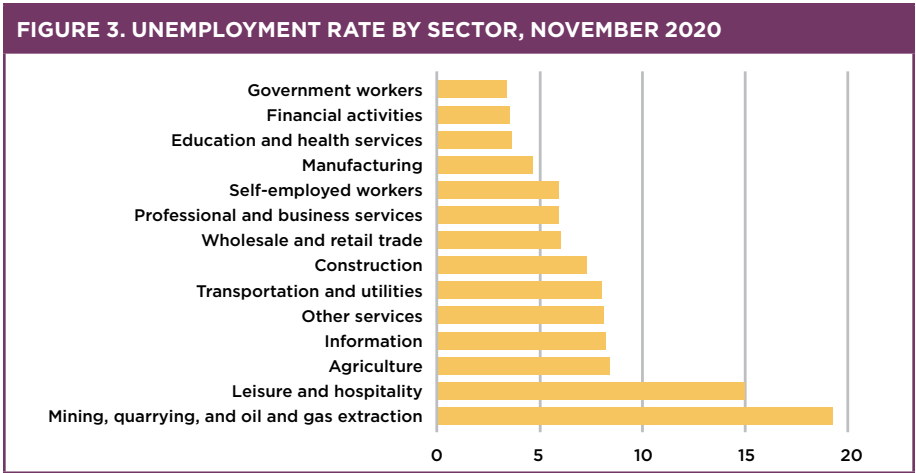**FIGURE 1. CIVILIAN UNEMPLOYMENT RATE**

**U.S. Unemployment Rate**



*Note.* Raw data from Bureau of Labor Statistics

**FIGURE 2. CAREER TRAJECTORIES OF DOD AWF EMPLOYEES**

**AWF Retention by Gender**



*Note.* Adapted from Ahn and Menichini (2019).

**FIGURE 3. UNEMPLOYMENT RATE BY SECTOR, NOVEMBER 2020**

| Sector | Rate |
|---|---|
| Government workers | ~3.5 |
| Financial activities | ~3.6 |
| Education and health services | ~3.8 |
| Manufacturing | ~4.7 |
| Self-employed workers | ~5.9 |
| Professional and business services | ~5.9 |
| Wholesale and retail trade | ~6 |
| Construction | ~7.3 |
| Transportation and utilities | ~8 |
| Other services | ~8 |
| Information | ~8.2 |
| Agriculture | ~8.4 |
| Leisure and hospitality | ~15 |
| Mining, quarrying, and oil and gas extraction | ~19 |

*Note.* Raw data from Bureau of Labor Statistics

However, it remains unclear when the economy can return to "business-as-usual" and how much vigor it will have on the rebound. Public health factors such as the efficacy of vaccines and their distribution, the spread of more infectious variants of COVID-19, and sustained use of masks and social distancing until herd immunity is reached, will all play a role. In addition, the recovery of the rest of the world; additional federal, state, and local fiscal stimuli; as well as permanent changes in the economy, such as expanded work-from-home and reconfiguration of global supply chains, may impact the private-sector labor market for years to come.

> **While job stability has always been a draw for the government sector, the state of the economy as well as the continuing uncertainty about the speed of economic recovery should make jobs in the DoD relatively much more attractive**

The impact of such changes to the private sector will inevitably affect the public sector, especially for the civilian workforce within the DoD. The combination of uncertainty in the private sector and a comparatively stable government sector is expected to alter their long-term career trajectories. Figure 2 shows the retention rate of Defense Acquisition Workforce workers, adapted from Ahn and Menichini (2019). The sample covers September 1987 to December 2018. Approximately 30% of workers leave the DoD after about 8 years of service. After approximately 25 years of experience, roughly

three-quarters of employees have left. While it is undeniably true that some employee turnover is beneficial (for instance, to jettison low-quality or unmotivated employees and bring in fresh talent), DoD leadership has consistently expressed a desire to hold on to highly skilled and experienced civilian workers (e.g., Department of Navy, 2018).

While the shock of COVID-19 has been felt in almost every sector of the labor market, the government sector has notably been shielded from the worst of the impact. Figure 3 shows that, as of November 2020, government workers experienced an unemployment rate around 4%. This rate is lower than workers in the education and health services fields, who have received much wider media coverage of labor shortages due to the health risks from their proximity to the pandemic.



While job stability has always been a draw for the government sector, the state of the economy as well as the continuing uncertainty about the speed of economic recovery should make jobs in the DoD relatively much more attractive. Indeed, this argument parallels what has been known for a long time in military recruiting: demand for military jobs is countercyclical to the state of the civilian economy. With the backdrop of this large, negative, persistent, and unpredictable shock to the civilian labor market, we model the long-run labor market decisions of civilian DoD employees using a dynamic programming framework.

## Model

In this section, we describe the different parts of the Dynamic Programming Model of employee retention that will be used to produce policy simulations.

We assume Defense Acquisition Workforce workers are rational decision makers who make career choices to maximize utility over their lifetime. The individual evaluates, at each decision point, all the costs and benefits involved in each possible choice, including pecuniary as well as nonpecuniary elements, which we describe in the following discussion. At the

beginning of each period (i.e., 1 year in this article), the worker chooses between leaving the Defense Acquisition Workforce to continue a career in the private sector or remaining in the public sector one more period. In addition, given that we observe in our data that only about 6% of workers who leave the Defense Acquisition Workforce return at a later date, plus the difficulty in discerning why they left (and why they returned), we further assume that leaving the Defense Acquisition Workforce is an irreversible decision.

We next describe all the costs and benefits (including monetary and nonmonetary elements) that the individual trades off in every decision point. We assume that the pecuniary components include:

- Defense Acquisition Workforce compensation, including basic pay, health insurance, locality adjustment, bonuses
- Compensation in the private sector



We also assume the Defense Acquisition Workforce employee is included in the Civil Service Retirement System (CSRS), and model public retirement accordingly. While our dataset contains employees from both the discontinued CSRS and the current Federal Employee Retirement System (FERS), we model the CSRS because more individuals belong to that system in our sample. For employees working in the private sector, we assume they are contributing to a 401(k) plan where the employer matches up to 10% of gross pay. As we note in the data section, the modal Defense Acquisition Workforce employee has a bachelor's degree or above and earns close to $100,000 at the highest paygrade attained. Workers with these characteristics in the civilian sector most often have employer matching 401(k) options.

The nonpecuniary components refer to the individual's taste or preference for a job in the Defense Acquisition Workforce versus a career in the private sector. These components attempt to capture the taste of those agents who prefer the higher predictability and stability of public sector employment, even at the cost of a lower salary compared to the private sector, and vice versa. To capture these relative preferences, we use taste parameters reflecting monetary-equivalent preferences for careers in the private versus the public sectors.

In particular, we use the following notation to construct the dynamic model:

- $W_t{}^m$ indicates compensation in the Defense Acquisition Workforce (including all pecuniary components) in period $t$

- $W_t^c$ denotes compensation in the private sector in period $t$

- $\omega^m$ is the public sector taste parameter, which captures the monetary-equivalent preference for a career in the Defense Acquisition Workforce

- $\omega^c$ is the private sector taste parameter, which captures the monetary-equivalent preference for a private sector career

- $T$ denotes the labor time horizon (number of working periods before final retirement)

- $\beta = \frac{1}{1+r}$ is the discount factor, where $r$ represents the subjective discount rate

- $\varepsilon_t^m$ and $\varepsilon_t^c$ are the random shocks affecting government and civilian jobs, respectively, in period $t$

- $E[.|\varepsilon_t - 1]$ indicates the expectation operator, given the shock in the previous period

> **Given that we observe in our data that only about 6% of workers who leave the Defense Acquisition Workforce return at a later date, plus the difficulty in discerning why they left (and why they returned), we further assume that leaving the Defense Acquisition Workforce is an irreversible decision.**

The maximization problem faced by the Defense Acquisition Workforce worker can be described by the following set of equations:

$$V_t^L = W_t^c + \omega^c + \beta E[V_{t+1}^L|\varepsilon_t^c] + \varepsilon_t^c \tag{1}$$

$$V_t^S = W_t^m + \omega^m + \beta E[V_{t+1}|\varepsilon_t^c, \varepsilon_t^m] + \varepsilon_t^m, \text{ and} \tag{2}$$

$$V_t = Max[V_t^L, V_t^S] \tag{3}$$

In these equations, superscript $S$ denotes the agent's choice to continue working one more period in the Defense Acquisition Workforce (i.e., $S$ = Stay). Alternatively, super-index $L$ indicates the individual's choice to quit

the Defense Acquisition Workforce job to continue a career in the private sector (i.e., $L$ = Leave). Therefore, $V_t^S$ denotes the (present) value of remaining in the public sector one more period, while $V_t^L$ indicates the (present) value of switching to the private sector. Equation (3) implies that the individual will decide to be part of the Defense Acquisition Workforce force in every period in which $V_t^S > V_t^L$ and will leave the force as soon as the opposite is true. In economics terms, the value of leaving the Defense Acquisition Workforce, $V_t^L$, represents the opportunity cost of choosing to stay in the public sector one more period.

Regarding stochastic variables $\varepsilon_t^m$ and $\varepsilon_t^c$, we assume they are independent and mean reverting over time ($t$ dimension). The specification of the random shocks is the following:

$$\varepsilon_t^c = \mu_c + \rho_c \varepsilon_{t-1}^c + \tau_t^c, \quad \tau_t^c \sim N(0, \sigma_c^2) \tag{4}$$

$$\varepsilon_t^m = \mu_m + \rho_m \varepsilon_{t-1}^m + \tau_t^m, \quad \tau_t^m \sim N(0, \sigma_m^2), \text{ and} \tag{5}$$

$$\tau_t^c \text{ independent of } \tau_t^m \tag{6}$$

That is, the random shocks evolve independently of each other, oscillating around their own long-run (unconditional) mean over time. In the context of equations (1)–(3), these stochastic variables could be interpreted as sudden and unpredicted events impacting the civilian and private sector salaries (i.e., $W_t^m$ and $W_t^c$, respectively) over time, stemming from, for instance, fluctuations in the business cycle. As we describe later, we use these random variables to introduce the COVID-19 shock. Ashenfelter and Card (1982) found that nominal wages are well represented by autoregressive models of order 1, also known as AR(1) processes. In this type of model, the forecast of the variable of interest is based on the current value of the variable. For instance, the prediction of nominal wages in the next period would be based

on the current value of nominal wages. Over time, random variables following AR(1) processes oscillate around their long-run means. Accordingly, equations (4) and (5) define AR(1) representations for the random shocks. These AR(1) processes play an important role for our main results as they allow shocks to persist over time, that is, to gradually fade as time passes. As we explain in more detail later, we use parameter $\rho$ to define the speed at which the economy (i.e., wages) recovers from a shock (e.g., from the COVID-19 outbreak). In terms of the optimization problem described in equations (1)–(3), random shocks $\varepsilon_t^m$ and $\varepsilon_t^c$ indicate state variables observed by the Defense Acquisition Workforce worker at the time of the decision.

# Data Description and Model Calibration

In this section, we describe the Defense Acquisition Workforce sample as well as the selection and calibration of the parameter values necessary to implement the Dynamic Programming Model described previously. In the next section, we show those parameters provide a good approximation of the long-run labor market outcomes for the representative worker in the Defense Acquisition Workforce.

## Data: The Acquisition Workforce

The Defense Acquisition Workforce comprises approximately 150,000 employees, covering the period September 1987–December 2018. Civilians make up about 90% of the workforce, while active-duty Service members make up the remaining 10%. The Defense Acquisition Workforce's mission is the "timely and cost-effective development and delivery of warfighting capabilities to America's combat forces" (DoD, 2015). The Defense Acquisition Workforce was responsible for overseeing the equipping and sustaining of the nation's military, spending over $1 trillion from FY 2016 to FY 2021. About 26% of the Defense Acquisition Workforce belongs to the engineering career field, followed by contracting at 19%. Historically, the Defense Acquisition Workforce was sharply reduced in size and capability during the 1990s. The DoD started to rebuild the Defense Acquisition Workforce in 2008 and increased it by approximately 50,000 employees over 13 years.

For this analysis, we restrict our sample to workers who were ever in the contracting, industrial property management, or purchasing fields. Our sample workers were born after January 1, 1950, but before December 31, 1980. Workers with birthdates outside this range are either too old, in that the environment in which they made their labor decisions may not reflect

current jobs in the Defense Acquisition Workforce; or too young, in that these workers have not had time to make labor decisions that are pivotal to their careers. Restricting the sample nets us over 2 million worker-month records, with over 13,000 unique workers tracked through their careers. Table 1 presents some summary statistics for our sample.

| TABLE 1. SUMMARY STATISTICS | | | | |
|---|---|---|---|---|
| **Variables** | **Mean** | **Std. Dev.** | **Min** | **Max** |
| Female | 0.632 | | | |
| Minority | 0.278 | | | |
| Disability | 0.202 | | | |
| Prior Military Service | 0.619 | | | |
| Has Bachelor's Degree | 0.547 | | | |
| Has Postgraduate Degree | 0.332 | | | |
| Gained Additional Education in AWF | 0.441 | | | |
| Career Length in AWF (in years) | 12.0 | (8.6) | 0.1 | 25.8 |
| Age at Entry | 33.0 | (8.2) | 15 | 65 |
| Age at Exit | 48.2 | (10.55) | 20 | 68 |
| Position Type: Professional | 0.657 | | | |
| (Ever Held)        Technical | 0.245 | | | |
|                   Blue-Collar | 0.018 | | | |
|                   White-Collar | 0.297 | | | |
| Ever Rated Not Fully Satisfactory | 0.575 | | | |
| Highest Salary | 95,143.67 | (30,410.74) | 27,397 | 189,600 |
| Observations | 13,590 | | | |

The workforce is predominantly white and female. Over half the workforce has a bachelor's degree or above. Compared to the civilian sector, careers in the Defense Acquisition Workforce are stable, with the average career length lasting well over a decade. This workforce is also highly paid, with the average employee earning almost $100,000 toward the end of their career. On average, workers in this sector begin their career at age 33, which indicates that the position in the Defense Acquisition Workforce is not their first job. In fact, a large number of these workers have prior military experience.

To rigorously assess the impact of the civilian sector on the attractiveness of the DoD position, every employee in the dataset must be "assigned" and can expect to earn a civilian wage. To accomplish this, we estimate a hedonic regression using the Outgoing Rotation Group (ORG) of the Current Population Survey (CPS). As this dataset contains a representative sample of workers in the United States, including, most importantly, those who are

in the government sector, it is possible to make an apples-to-apples comparison with workers in the private sector. (See Ahn and Menichini [2021] for a detailed description.)

We run a hedonic regression using the individual socio-demographic characteristics, professional and education experience, and locality indicators from the ORG of the CPS, which broadly match the Defense Acquisition Workforce variables summarized in Table 1, to obtain predicted civilian and government sector wages. The difference in the wages across private and public sectors, conditioned on individual characteristics, defines the government sector "wage penalty."

## Calibration Results

Before simulating the model described in equations (1)–(3), we define the parameter values, which we show in Table 2 and subsequently describe. We can observe in Table 2 that all parameter values, except compensation, are constant over the career of the Defense Acquisition Workforce employee.

| TABLE 2. PARAMETER VALUES | |
|---|---|
| **Parameter** | **Value** |
| $W_t^m$ | 1 |
| $W_t^c$ | 1.1761 |
| $T$ | 25 |
| $\beta$ | 0.95 |
| $\omega^m$ | 1.2782 |
| $\omega^c$ | 1 |
| $\mu_m$ | 0 |
| $\mu_c$ | 0 |
| $\rho_m$ | 0.90 |
| $\rho_c$ | 0.90 |
| $\sigma_m$ | 0.005 |
| $\sigma_c$ | 0.005 |

As we described earlier, estimates from the hedonic regressions suggest that income in the private sector (i.e., $W_t^c$) is, on average, around 17.61% higher than in the Defense Acquisition Workforce (i.e., $W_t^m$) for individuals with similar characteristics. For this reason, after initially normalizing $W_t^m = 1$, we let $W_t^c = 1.1761$. We then add the income from the different retirement systems; thus, compensation changes over time. The data described earlier also show that the longest observed labor time horizon among all individuals

is 25 years. For that reason, we let $T=25$. The subjective discount factor is assumed to be 0.95, implying an interest rate of 5.26%, which is similar to the average 30-Year T-Bond Constant Maturity Rate reported by the Federal Reserve Bank of St. Louis for the period covered by the dataset.



Regarding the taste parameters, we calibrated parameter $\omega^m$ so that the survival curve predicted by the model approximates the empirical survival curve as closely as possible via grid search (we show the graphical results of this calibration in the next section). In more technical terms, the calibration exercise searches for the value of $\omega^m$ that minimizes the summed squared distance between the points of the empirical Defense Acquisition Workforce survival curve and the points of the survival curve predicted by the model. As Table 2 displays, we normalize $\omega^c=1$ and, from the calibration exercise, we obtain $\omega^m=1.2782$. These values are similar to those estimated by Ahn and Menichini (2021), and imply that the representative Defense Acquisition Workforce employee prefers the Defense Acquisition Workforce over the private sector.

The remaining parameter values in Table 2 refer to the stochastic process of the random variables $\varepsilon_t^m$ and $\varepsilon_t^c$. We follow Ashenfelter and Card (1982) to define the parameter values that govern the AR(1) processes of those terms. Accordingly, we let parameters $\mu_m$ and $\mu_c$ be equal to zero, we assume values of 0.005 for the standard deviation of the random shocks, $\sigma_m$ and $\sigma_c$, and let the mean-reversion coefficients, $\rho_m$ and $\rho_c$, be equal to 0.9. These values depict the historical behavior of the shocks. In particular, those observed values of the mean-reverting coefficients suggest that wages have a high level of persistence over time; thus, the effects of shocks require a long time to disappear.

# Model Solution and Policy Simulations

In this section, we describe our policy simulations to forecast evolution in the behavior of the representative Defense Acquisition Workforce worker under a number of scenarios with differing speed rates of economic recovery from a large, abrupt, and unanticipated negative impact (i.e., COVID-19) to the private sector. This is a major systematic event that adversely affects all sectors of the economy, except for the public or government sector, which we assume keeps its employment constant (in fact, any future unanticipated national shock to the economy and/or public health that is concentrated mainly in the private sector can be expected to operate in a similar manner). The assumption that the government sector is not affected by the shock is consistent with the assumption of independent random shocks in equation (6).
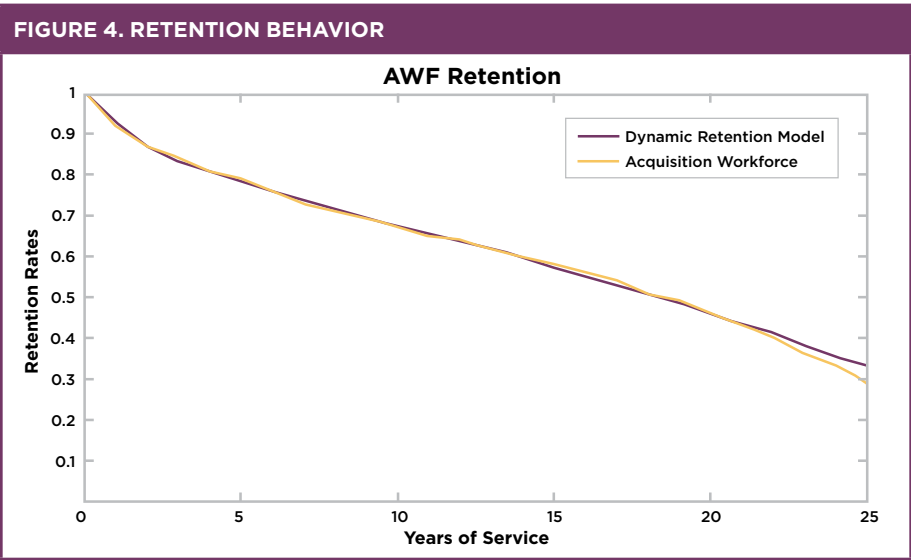
Concisely, we introduce a large negative civilian shock at a point in time. Then, we allow the system to recover and converge back to the steady state. We start analyzing retention behavior assuming the economy recovers according to the empirical historical speed. However, given the observed recovery from the current pandemic seems to be, so far, much faster than normal, we also study the retention implications of different scenarios for the speed of recovery. We "control" the speed of recovery of the economy by setting the autoregressive term, $\rho$, which controls the velocity at which shocks gradually disappear over time.

While the private sector goes through its gyrations, at every period the representative Defense Acquisition Workforce agent in our model surveys the current state of the private sector, forecasts the evolution of the state of the economy, and makes the *ex ante* optimal decision to stay or leave the Defense Acquisition Workforce. We describe the simulation procedure in more detail next.

We solve the model described in equations (1)–(3) via backward induction. (See Rust [1987] for an empirical treatment.) That is, we start from the final period (i.e., $t = T = 25$) and decide whether to stay one more (final) period in

the Defense Acquisition Workforce or to leave for the private sector. We then move one period backward (i.e., $t = 24$) and select to stay one more period or to leave the Defense Acquisition Workforce, considering the value from the optimal decision in period $T = 25$. We continue moving backward, deciding rationally in every period, until we reach the present period (i.e., $t = 0$). This solution characterizes the retention behavior of a representative Defense Acquisition Workforce employee in all possible states of the economy.

**FIGURE 4. RETENTION BEHAVIOR**



**FIGURE 5. PROBABILITY OF LEAVING**

We then stochastically simulate the model forward (i.e., over the 25 years of work) 100,000 times, which produces the stay/leave decisions of 100,000 employees in all possible different situations over the labor period. These simulations summarize the retention behavior of the representative employee, which we show in Figure 4. The figure exhibits the calibrated, model-predicted survival curve of the representative individual (purple line) and displays the cumulative probability of the worker staying in the Defense Acquisition Workforce after a certain period of time. For example, the figure suggests that the likelihood that the employee is still part of the Defense Acquisition Workforce after 10 years is about 65%. The figure also shows the empirical survival curve for the Defense Acquisition Workforce employees (yellow line) from the data described previously, suggesting that the calibrated model predicts actual behavior quite closely. While Figure 4 displays the retention behavior of a representative Defense Acquisition Workforce employee, each demographic group described in Table 1 would have its own survival curve.
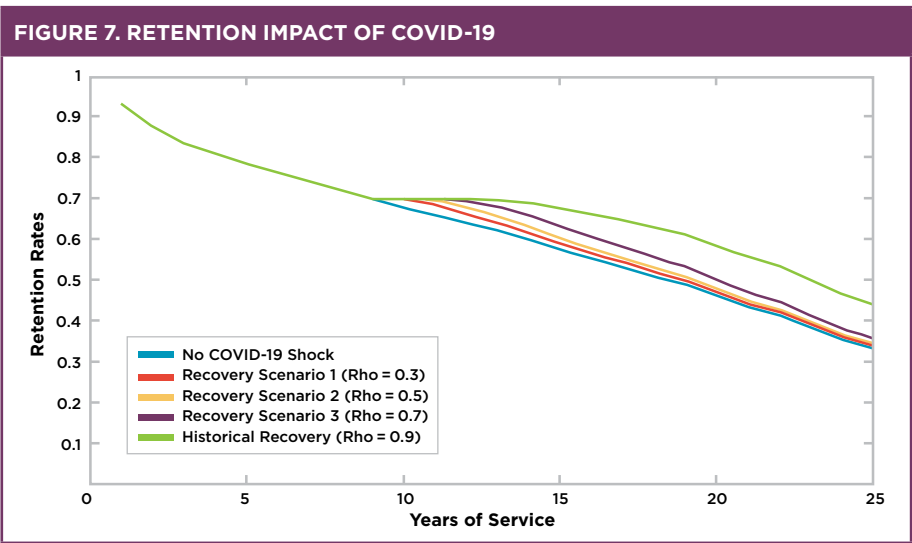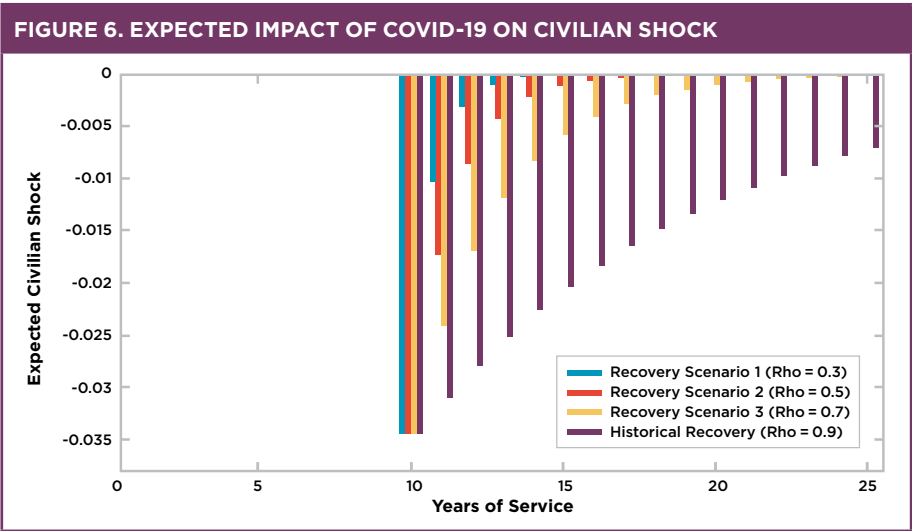
> **Clearly, the historical coefficient implies it would easily take a decade or more to return to normality. However, a year after the appearance of the virus, the economy seems to be recovering much faster than suggested by historical terms.**

Associated with the previous survival curves are the yearly, model-predicted probabilities of leaving the Defense Acquisition Workforce, which we show as the blue line in Figure 5. The retention rate is relatively high every year, as is shown by the fact that the likelihood of leaving is always below 10% per year, and below 5% in the great majority of years. In addition, the probability of leaving is high initially, and diminishes through time before increasing again toward the end of the individual's career. For instance, the probability that the employee departs from the Defense Acquisition Workforce in year 10 is around 2%. As before, we also show the empirical likelihood of leaving (yellow line) for comparison purposes.

We then proceed to shock the model with a large negative random draw on the civilian side (i.e., $\varepsilon_t^c$) at year 10. The shock is equivalent to 3 standard deviations below the mean and is intended to capture the large effect of the sudden appearance of COVID-19. In economic terms, given the calibration shown in Table 2, this shock could be interpreted as a roughly 1.5% reduction

in the civilian salary, $W_t^c$, while the public sector salary, $W_t^m$, remains unchanged. The fact that the random shocks (both $\varepsilon_t^m$ and $\varepsilon_t^c$) are mean reverting over time implies that the impact of the negative shock on the civilian salary gradually disappears as time passes. As mentioned before, the speed of return to the pre-shock state will depend on the mean-reversion coefficient, $\rho$.

**FIGURE 6. EXPECTED IMPACT OF COVID-19 ON CIVILIAN SHOCK**



**FIGURE 7. RETENTION IMPACT OF COVID-19**



In Figure 6 we show, given the initial negative shock, how the shocks are expected to evolve over time for four different values of the coefficient of mean-reversion. The purple bars depict the historical case, which is based
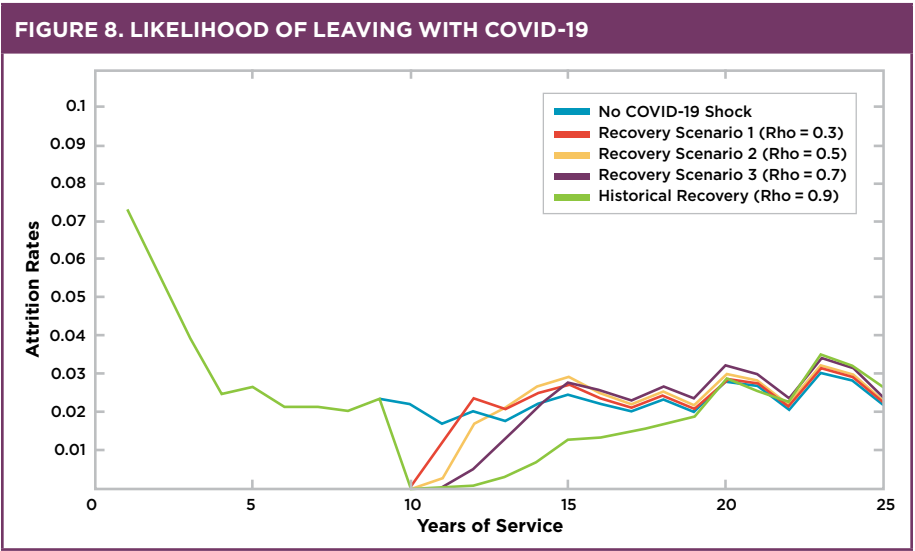
on the observed historical mean-reversion coefficient of $\rho = 0.9$. Clearly, the historical coefficient implies it would easily take a decade or more to return to normality. However, a year after the appearance of the virus, the economy seems to be recovering much faster than suggested by historical terms. We attempt to capture the faster rebound by reducing the coefficient of mean-reversion (i.e., via a quicker dissipation of the shock). Accordingly, we analyze three different scenarios featuring dissimilar speeds of recovery, all of which are faster than the historical speed. Scenario 1, with the blue bars and $\rho = 0.3$, represents the case of a relatively faster return to the pre-COVID economy. On the other hand, the yellow bars in scenario 3, with $\rho = 0.7$, reflect a slower recovery to normality as compared to scenario 1. In between are the red bars of scenario 2, showing an intermediate speed of recovery with $\rho = 0.5$. Even in the more optimistic recovery scenario 1, the effects of the large negative shock clearly remain in place for some years. While we acknowledge that the magnitude and persistence of the shocks are speculative, they are informed by very recent (and ongoing) research. Many scholars are currently attempting to forecast the long-run impact of COVID-19 on the economy. (See Petrosky-Nadeau and Valetta [2020], for an example of such ongoing research.)



The effect on retention behavior of the representative Defense Acquisition Workforce worker can be observed in Figure 7. The figure shows that, during the initial 10 years, the retention behavior is equivalent to the blue line in Figure 4. At year 10, the COVID-19 shock happens, and the retention behavior changes considerably. As mentioned before, we study the retention behavior in four different contexts. The green line shows the retention impact of the virus under historical terms (i.e., $\rho = 0.9$). The other lines depict the expected retention behavior for three faster rates of economic recovery (i.e., $\rho = 0.3$, $\rho = 0.5$, and $\rho = 0.7$ for recovery scenarios 1, 2, and 3, respectively). In all cases, a kink and sudden flattening of the curve is evident, suggesting that individuals stay longer in the Defense Acquisition Workforce in an

attempt to avoid the sharp negative effect of the virus shock on the civilian labor market. Depending on the speed of recovery, it might take a substantial amount of time for the employee to return to the pre-shock retention behavior. For instance, in the historical case it takes around 10 years for the representative employee to return to the previrus retention behavior, while in scenarios 1, 2, and 3, the return to normality takes roughly 2, 3, and 5 years, respectively. These long-lasting effects on retention behavior have important implications for the hiring policies of the public sector.

It is worth noting that the time required to return to the "original" behavior specified previously does *not* mean that all workers will choose to delay leaving the Defense Acquisition Workforce by several years due to the impact of COVID-19. Instead, all employees will process the negative shock in the civilian economy as making the Defense Acquisition Workforce job more attractive. Until the shock fully dissipates, the DoD position will be more attractive than if no global pandemic had occurred. However, given the substantial wage premium in the civilian sector, the pandemic shock does not need to completely disappear before workers who were planning to move to the civilian sector resume their plans.



**FIGURE 8. LIKELIHOOD OF LEAVING WITH COVID-19**

To complement the analysis of the return to the pre-COVID context, we present Figure 8. The figure shows the model-predicted yearly probabilities of leaving the Defense Acquisition Workforce for the four different values of parameter $\rho$. The green line shows the retention behavior in the historical recovery scenario, confirming that it takes around 10 years to return to the pre-COVID retention behavior (the latter is represented by the no-COVID-19-shock blue line). The red, yellow, and purple lines, reflecting faster speeds

of economic rebound, suggest that around 2, 3, and 5 years, respectively, are required to eliminate the effects of the COVID-19 shock on retention. In all four scenarios, the likelihood of leaving the Defense Acquisition Workforce goes roughly to zero in the year of the shock, and then slowly starts to return to the no-shock levels as time passes and the effects of the shock dissipate.
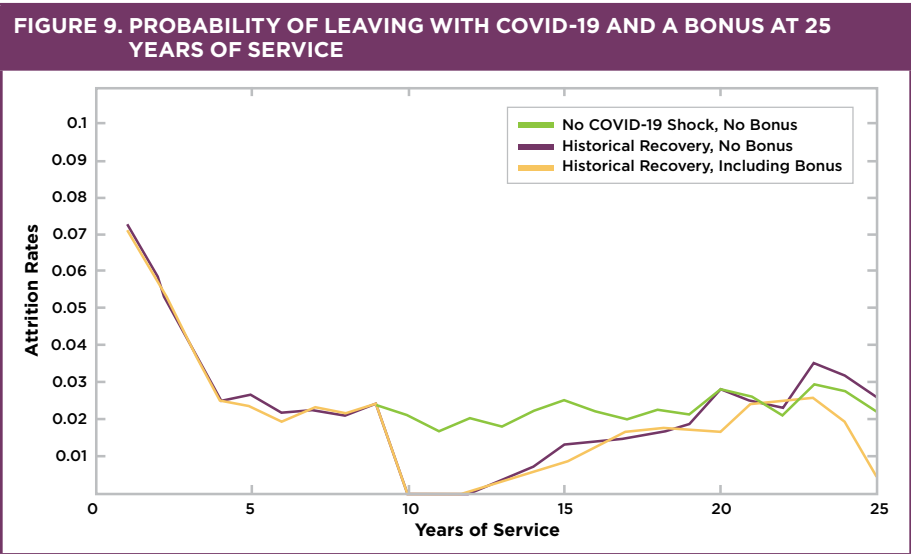
> **Given the substantial wage premium in the civilian sector, the pandemic shock does not need to completely disappear before workers who were planning to move to the civilian sector resume their plans.**

It is also important to note that, after the return to normality, the probability of leaving is higher in the slower recovery scenarios and lower in the faster rebound scenarios. More generally, after the COVID-19 shock dissipates, in all cases with shock, the likelihood of leaving is higher than in the no-shock case, with that probability increasing in parameter $\rho$. Indeed, the slower the recovery from the pandemic (i.e., higher $\rho$ value), the larger the magnitude of exit probability after the recovery. This outcome suggests that, as more people decide to stay longer in the Defense Acquisition Workforce during the pandemic, when the economy returns to normal the pent-up demand to leave for the private sector is expressed as a higher likelihood of leaving in the later years. This implies an opportunity as well as a problem for the Defense Acquisition Workforce leadership. While a slower recovery may induce more employees to stay longer, it cannot be a permanent solution to retain high-ability workers. A higher $\rho$ will result in a much sharper exit of workers from the Defense Acquisition Workforce once the civilian economy recovers.

To retain these workers, fundamental (and traditional) personnel policy reforms will be required. For example, a pay increase or expansion of benefits before the civilian sector fully recovers may permanently induce senior workers to remain in the Defense Acquisition Workforce. Similarly, a one-time retention bonus, set far enough into the future when the civilian economy is back to normal, could prevent that exit.

**FIGURE 9. PROBABILITY OF LEAVING WITH COVID-19 AND A BONUS AT 25 YEARS OF SERVICE**



Although a full analysis of the available policy reforms is outside the scope of this article, we show with more detail one particular way by which that expected long-term effect could be counteracted. In particular, we analyze the effect of a one-time bonus on the probability of leaving the Defense Acquisition Workforce when the economy returns to normality. We assume the bonus is equivalent to 25% of the individual's monthly salary and is paid at year-of-service 25 (with the virus shock occurring at year 10). Figure 9 shows the main results of this exercise. The expected bonus has a fairly small effect on employee retention in the early- and mid-career years, as the retention rates are almost equivalent with and without the bonus.

However, as expected, the effect of the bonus is more visible in the final years of the employee's career, when the economy has fully recovered from the COVID-19 shock. Without the bonus (purple line), the likelihood of leaving is substantially higher than with the bonus (yellow line), suggesting that, indeed, a bonus would induce experienced employees to stay longer in the Defense Acquisition Workforce after the recovery. Finally, the bonus is just one of the tools available to the Defense Acquisition Workforce to affect individual retention behavior (for instance, salary raises would be another useful tool).

## Conclusions

As of early 2021, the overall unemployment rate in the United States stands at 6.2%—an 8-percentage point decrease in just 8 months from the worst unemployment rate in almost 90 years arising from the COVID-19 global pandemic, yet still almost double the unemployment rate from just one year ago. While the recovery has been as dramatic as the decline, the future remains very much in doubt. For example, in December 2020, payrolls shrank by 140,000. Outlook has considerably brightened since, but whiplash in the long-run forecast of economic recovery itself adds uncertainty to future labor market prospects in the civilian market.

> Forward-looking leaders should regard these simulation results not as predictions of the future, but as guides to help set personnel policies that are flexible and adjustable, and even take advantage of gyrations in the civilian economy.

In this environment, we analyzed the potential impact of the economic recovery on the labor market trajectory of the Defense Acquisition Workforce. The contrast in stability of jobs in the government compared to the private sector should increase the attractiveness of DoD jobs, especially if the recovery proves to be slow or unpredictable. We built and calibrated a dynamic programming model of employee retention behavior, analyzed the impact of a negative persistent shock to the civilian sector, and simulated different recovery paths.

The larger the magnitude of the negative shock to the civilian economy, the more our results show that government positions become more attractive; while the slower the economic recovery, the more highly employees may value government positions compared to the prepandemic period for several years.



While this environment can increase retention of the average worker from the Defense Acquisition Workforce, leadership should understand that, eventually, recovery of the civilian sector will push down the relative desirability of government jobs. This may lead to a speedy exodus of many senior-level workers who were being held back due to economic uncertainty. Personnel planning without considering the temporary increment in retention at the beginning of the shock may lead to overhiring, especially at the junior-levels. Conversely, short-sighted reductions in hiring due to the initial impacts of the negative shock may lead to a hollowing out of the workforce, once the shock impact wanes. In addition, as the economy recovers, there may be fundamental structural changes to the labor market that remain, changing the valuation of both government and private sector jobs in unpredictable ways. Forward-looking leaders should regard these simulation results not as predictions of the future, but as guides to help set personnel policies that are flexible and adjustable, and even take advantage of gyrations in the civilian economy.

**Acquisition Research Program Symposium 2021**

**Optimal Long-Run Talent Management of the DoD AWF in Response to COVID-19: A Dynamic Programming Approach**

Dr. Tom Ahn
Dr. Amilcar Menichini

**GRADUATE SCHOOL OF DEFENSE MANAGEMENT
NAVAL POSTGRADUATE SCHOOL**

## SCAN TO WATCH

Learn more about this article by watching Dr. Tom Ahn and Dr. Amilcar Menichini's presentation, *Optimal Long-Run Talent Management of the DoD AWF in Response to COVID-19.*

# References

Ahn, T., & Menichini, A. (2019). *Acquisition research program sponsored report series: Retention analysis modeling for the acquisition workforce* (Report No. NPS-HR-20-001). Naval Postgraduate School. https://dair.nps.edu/bitstream/123456789/2775/1/NPS-HR-20-001.pdf

Ahn, T., & Menichini, A. (2021). *Acquisition research program sponsored report series: Retention analysis modeling for the acquisition workforce II* (Report No. NPS-HR-21-031). https://dair.nps.edu/bitstream/123456789/4317/3/NPS-HR-21-031.pdf

Asch, B. J., Mattock, M. G., & Hosek, J. (2013). *A new tool for assessing workforce management policies over time*. RAND. https://www.rand.org/pubs/research_reports/RR113.html

Ashenfelter, O., & Card, D. (1982). Time series representations of economic variables and alternative models of the labour market. *The Review of Economic Studies, 49*(5), 761–781. https://doi.org/10.2307/2297188

Barron, J., Berger, M., & Black, D. (2006). Selective counteroffers. *Journal of Labor Economics, 24*(3), 385–409. https://doi.org/10.1086/504275

Congressional Budget Office. (2021). *An overview of the economic outlook: 2021 to 2031*. https://www.cbo.gov/system/files/2021-02/56965-Economic-Outlook.pdf

Department of Defense. (2015). *DoD acquisition workforce strategic plan—FY 2016–FY 2021*. https://www.hci.mil/docs/dod_acq_workforce_strat_plan_fy16_fy21.pdf

Department of Navy. (2018). *DoN acquisition workforce FY 19–24 strategic plan*. https://www.secnav.navy.mil/rda/workforce/Documents/StrategyPolicy/AWF_Strategic_Plan_-_24_April_2019.pdf

Dobriansky, J. (2009). Acquisition workforce challenge–Motivation for government vs. industry employment. *Defense Acquisition Review Journal, 16*(1), 69–83. https://www.dau.edu/library/arj/ARJ/arj50/ARJ50.pdf

Fallick, B., Fleishman, C., & Rebitzer, J. (2006). Job-hopping in Silicon Valley: Some evidence concerning the microfoundations of a high-technology cluster. *Review of Economics and Statistics, 88*(3), 472–481. https://doi.org/10.1162/rest.88.3.472

Fullerton, R. L. (2003). An empirical assessment of U.S. Air Force pilot attrition. *Defense and Peace Economics*, *14* (5), 343–355. https://doi.org/10.1080/10242690302922

Gibbons, R., & Katz, L. (1991). Layoffs and lemons. *Journal of Labor Economics, 9*(4), 351–380. https://doi.org/10.1086/298273

Goldberg, M. (2001). *A survey of enlisted retention: Models and findings* (CRM D0004085.A2/Final). Center for Naval Analyses. https://www.cna.org/CNA_files/PDF/D0004085.A2.pdf

Golding, H., & Gregory, D. (2002). *Sailors' willingness to complete sea tours: Does money matter?* (Report No. CRM D0006886.A2/Final). Center for Naval Analyses. https://www.cna.org/CNA_files/PDF/D0006886.A2.pdf

Guo, C., Hall-Partyka, P., & Gates, S. M. (2014). *Retention and promotion of high-quality civil service workers in the DoD acquisition workforce.* RAND. https://www.rand.org/pubs/research_reports/RR748.html

Hattiangadi, A., Lee, G., & Quester, A. (2004). *Recruiting Hispanics: The Marine Corps experience final report* (Report No. CRM D0009071.A2/Final). Center for Naval Analyses. https://www.cna.org/CNA_files/PDF/D0009071.A2.pdf

International Monetary Fund. (2021, January). *World economic outlook update*. https://www.imf.org/en/Publications/WEO/Issues/2021/01/26/2021-world-economic-outlook-update

Jenkins, A. K. (2009). Keeping the talent: Understanding the needs of engineers and scientists in the defense acquisition workforce. *Defense Acquisition Review Journal, 16*(1), 18–32. https://www.dau.edu/library/arj/ARJ/arj50/ARJ50.pdf

Kotzian, M. (2009). Leadership and cultural change: The challenge to acquisition workforce retention. *Defense Acquisition Review Journal, 16*(1), 32–52.  https://www.dau.edu/library/arj/ARJ/arj50/ARJ50.pdf

Lazear, E. (1986). Raids and offer matching. *Research in Labor Economics, 8*, 141–165.

Petrosky-Nadeau, N., & Valetta, R. (2020). *Unemployment paths in a pandemic economy* [Working paper]. Federal Reserve Bank of San Francisco. https://doi.org/10.24148/wp2020-18

Rust, J. (1987). Optimal replacement of GMC bus engines: An empirical model of Harold Zurcher. *Econometrica, 55*(5), 999–1033. https://doi.org/10.2307/1911259

Schwartz, M., Francis, K. A., & O'Connor, C. V. (2016). *The Department of Defense acquisition workforce: Background, analysis, and questions for Congress*. Congressional Research Service. https://apps.dtic.mil/sti/citations/AD1014172

Warner, J. (1995). The economics of military manpower. In K. Hartley & T. Sandler (Eds.), *Handbook of Defense Economics, vol. 1* (pp. 347–398). Elsevier. https://doi.org/10.1016/S1574-0013(05)80015-8

Wilson, R. (1969). Competitive bidding with disparate information. *Management Science, 15*(7), 446–518. https://www.jstor.org/stable/2628640?origin=JSTOR-pdf

## Author Biographies

### Dr. Tom Ahn

is an Assistant Professor in the Graduate School of Defense Management at the Naval Postgraduate School. After serving in The Republic of Korea Army for 3 years, he completed a 2-year post-doctorate position at Duke University. He taught at the University of Kentucky for 7 years and has been at the Naval Postgraduate School since 2017. Dr. Ahn has published in *Journal of Econometrics*, *Journal of Business and Economic Statistics*, and *Journal of Urban Economics*.

*(E-mail address: sahn1@nps.edu)*

### Dr. Amilcar A. Menichini

is an Associate Professor in the Graduate School of Defense Management at the Naval Postgraduate School. Before joining the Naval Postgraduate School, he studied to attain his PhD in Finance from the University of Arizona. Dr. Menichini has published in *The Financial Review*, *Review of Quantitative Finance and Accounting*, and *Southern Economic Journal*.

*(E-mail address: aamenich@nps.edu)*