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### Evaluation of the 2007 Army Menu of Incentives Program

#### Estimates of Returns and Rents WEAI 2021

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#### About This Publication

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#### **Executive Summary**

The U.S. Army implemented the Menu of Incentives Program (MOIP) in September 2007 to improve retention of Army captains. Eligible officers could select one of five incentive options in exchange for a non-concurrent Active Duty Service Obligation (ADSO). More than 90 percent of participants selected the Critical Skills Retention Bonus (CSRB), which ranged from \$25,000 to \$35,000 and carried a three-year ADSO requirement. Institute for Defense Analyses researchers estimate the bonus cost per service-year gained and the share of total bonus costs that the Army paid in economic rent for the initial cohort of eligible officers in September 2007.

When offering any bonus, the Army inevitably pays more than the minimum amount required to obtain an additional ADSO from the officers who accept. These economic rents arise because some participants would have accepted a smaller bonus in exchange for the incurred ADSO. Officers may also have been planning to serve at least a portion of the time covered by the ADSO absent the bonus. Service members who are more likely to remain in the military longer without an incentive will consider an ADSO extension less detrimental; therefore, bonus programs are most likely to enroll and compensate those who would have stayed anyway. This "adverse selection" problem inflates the costs paid in economic rent and reduces the total number of marginal service-years that the Army actually gains through the bonus program.

We train a machine learning model to predict the number of months that each eligible officer would likely have served in a counterfactual scenario absent the MOIP. We then simulate acceptance decisions and calculate economic rent and the marginal number of service-years gained by the Army through the bonus. We find that prior to program implementation, the Army could have expected to gain about 2,800 marginal service-years from the initial cohort of program participants, at a cost of \$110,000 in bonuses per service-year gained. This high cost per service-year reflects the finding that most officers who were eligible for the program were expected to serve a large portion of their ADSO extension period anyway absent the MOIP. We also find that the Army could have expected to pay more than 62 percent of the program's direct costs in economic rent.

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## Evaluation of the 2007 Army Menu of Incentives Program

### Estimates of Returns and Rents

### WEAI 2021

Julie Lockwood James Bishop Alan Gelder Christopher Oswald

June 2021

### In today's talk...

Overview of the 2007 Menu of Incentives Program (MOIP) Historical context and implementation details

Scope and Objectives Research questions, data requirements and limitations

#### Estimation Methodology

Forecasting survival probabilities, imputing existing active-duty service obligations (ADSOs), and simulating reservation prices

Results and Sensitivity Analyses Model visualizations, summary of outcomes, and changes to key assumptions

### Recommendations

Considerations for future Army retention initiatives

# **Overview of the 2007 MOIP**

# Army's 2007 Menu of Incentives Program attempted to retain captains

Implemented in September 2007 after years of deployments to Iraq/Afghanistan with no end in sight

Offered to nearly all active-duty captains in 17 career branches

Not targeted by performance quality, expected attrition, etc.

Captains could choose one of five retention incentives in exchange for an additional service commitment

68% of eligible officers accepted a retention incentive

### MOIP Overview: Sudden, short, and broad

Sudden, one-time retention incentive for Army captains (O3s) Historical (and current) gap in retention incentives for junior officers Officers most likely to exit as captains No indication of whether it would be repeated

3-month window for accepting the MOIP Program announced September 11, 2007, in MILPER-07-237 Deadline was December 14, 2007 Some incentives had earlier deadlines (October 19 and November 23)

### MOIP Overview: Sudden, short, and broad

Broad eligibility covered vast majority of captains Active duty only (no Guard or Reserve) Accessed in 1 of 17 career branches Date of rank between April 1, 2002, and November 1, 2007 Not already considered for in-the-zone promotion to major Not already in a special program (e.g., JAG\* education, grad school) No disciplinary issues

# Acceptance incurred a non-concurrent service obligation

Retention Incentive	Active Duty Service Obligation (ADSO)	
Critical Skills Retention Bonus (CSRB) of \$25,000, \$30,000, or \$35,000 based on accession branch	36 months	
Graduate school (master's program)	3 days for every 1 day in school	
Military schooling: Ranger School Defense Language Institute	Ranger: 12 months Language: 3 days for every 1 day 36 months 36 months	
Career branch or functional area of choice		
Choice of next post		
Non-concurrent: beginning after all o	ther ADSOs end	

Some non-cash options were only non-concurrent with commissioning ADSO

# Cash incentive was immediate and broadly offered; other incentives were limited and distant in time

All non-cash incentives flagged as limited availability Priority given to those with date of rank from January 1, 2006, to November 1, 2007

If officers were denied due to limited availability, not clear from MOIP announcement whether they could reapply

Cash was surest option for short program window

Cash incentive was to be paid within 90 days of final contract Other incentives could be 1 or more years in the future

93% of participants selected the cash option3% selected a change of branch

# Scope and Objectives

### What did the Army get out of the MOIP?

68% of eligible officers accepted a retention incentive Average direct cost was over **\$30,000** per officer for 3-year ADSO

How much service time did these officers promise beyond what they would have served otherwise?

We estimate the average cost was \$110,000 per service-year gained

How much of the program costs could the Army have expected to pay in economic rents?

### Definitions

**Reservation price** – Minimum bonus amount an officer would take in exchange for accepting a given ADSO

**Economic rents** – Bonus amount minus reservation price

We estimate that the Army could have expected to pay about **62%** of the program's direct costs in economic rents

# Estimating these counterfactual outcomes requires three pieces of information

How long would eligible officers likely have served anyway absent the MOIP?

Need each officer's survival curves as of August 2007

How much time were officers already committed to serving? Need point on survival curve where the additional ADSO would begin

What is the officer's reservation price? Need to determine whether the bonus would likely be accepted

### Numerous data issues motivate our methods

Army did not archive data on who accepted the MOIP Not recorded in Army databases (e.g., TOPMIS, TAPDB) or by DMDC\* Prevents comparisons of outcomes among various margins Prevents long-term analysis of how careers unfolded

Army did not archive data on existing ADSOs before the MOIP We estimate ADSOs from accession source and commissioning date Does not capture other ADSOs (e.g., PCS,\* education)

Our analysis focuses on what the Army could have expected when they launched the MOIP

\* TOPMIS = Total Officer Personnel Management Information System; TAPDB = Total Army Personnel Database; DMDC = Defense Manpower Database Center; PCS = Permanent Change of Station

### Numerous data issues motivate our methods

To accomplish this analysis, we need survival curves and reservation prices

Survival curves not observable, but can be estimated We estimate them using Retention Prediction Model – Army (RPM-A)

Reservation prices are fundamentally unobservable We simulate them from distributions exhibiting core principles

# **Estimation Methodology**

### We need to estimate survival curves

For forecast horizon  $t \in \{1, ..., T\}$ :

### Marginal survival probabilities

Given an officer with feature values v serves to month t - 1, what is the probability that months served m is at least t?

 $p(v) = \langle p_t(v) \rangle = \langle P(m \ge t \mid m \ge t - 1)(v) \rangle$ 

#### Survival curve

Cumulative product of the marginal survival probabilities up to t $s(v) = \langle s_t(v) \rangle = \langle \prod_{j=1}^t p_j(v) \rangle$ 

### Restricted mean survival time (RMST)

Area under survival curve during the 36-month ADSO extension where g is number of months remaining on existing ADSO

$$r(v) = \sum_{j=g+1}^{g+36} s_j(v)$$

### When will the non-concurrent MOIP ADSO fall?



#### Restricted mean survival time

Area under survival curve during the 36-month ADSO extension where g is number of months remaining on existing ADSO

$$RMST \equiv r(v) = \sum_{j=g}^{g+36} s_j(v)$$

# We use machine learning with a survival loss function to estimate the survival probabilities

More flexible than traditional tools for survival analysis Kaplan-Meier: H(t)—hare surviving to time horizon tProportional Hazards: H(t) f(x)—now a function of feature values Our method: H(t, x)—allows interactions with time and features We effectively compute  $f_t(x)$  for each forecast horizon

IDA's Finite-Interval Forecasting Engine (FIFE) fits a binary prediction model for each future time horizon Outputs person-level survival curves from panel data input

Retention Prediction Model – Army (RPM-A) results from applying the FIFE to Army personnel panel data

# We fit to hundreds of features using monthly data from January 2000 to August 2007

Data Category	Types of Features		
Career	Pay grade, military occupation, accession source, duty station, education level, test scores		
Demographics	Age, gender, race, ethnicity, faith group, citizenship status, home of record		
Family	Marital status; number, age, relationship, and location of dependents		
Рау	Allowances, basic pay, skill-based incentives, hazard pay, select bonuses, tax withholdings		
Unit Traits	Unit size, demographics, education levels, test scores		
Deployments	Deployment frequency and duration (at unit and individual levels), combat zone status		
Casualties	Frequency, severity, and cause of casualties (at unit and occupation levels)		
External Economic Conditions	Unemployment rates and earnings for civilian occupations by state and experience level		

# We use commissioning source and date to impute existing ADSOs

Commissioning Source	Commissioning ADSO
U.S. Military Academy	5 years
Reserve Officer Training Corps (ROTC) with scholarship	4 years
ROTC without scholarship	3 years
Officer Candidate School	3 years

For Army captains with a date of rank in the eligible window, 82% had fulfilled their commissioning ADSO before the MOIP Underestimating existing ADSOs may overestimate our rents

### Reservation prices are random variables

We assume officer *i*'s reservation price  $x_i$  depends on officer's observed features  $v_i$  with some random mean-zero variation  $\varepsilon_i$ 

$$x_i = \mu(v_i) + \varepsilon_i, \qquad E[\varepsilon_i] = 0$$

We further assume that  $x_i$  is a function of:

RMST r—amount of MOIP ADSO the officer would have served anyway Bonus b—a function of accession branch and associated attributes a

 $x_i = \mu(r(v_i), b(a_i)) + \varepsilon_i = \mu(r_i, b_i) + \varepsilon_i, \qquad E[\varepsilon_i] = 0$ 

An officer accepts a bonus if  $b_i > x_i$ Economic rents are  $b_i - x_i$  if  $b_i > x_i$  and zero otherwise

### We assume reservation prices satisfy the following

A1. The distribution matches an expected acceptance rate We use the actual take-up rate of 68% as a baseline

$$\frac{1}{|N|} E\left[\sum_{i \in N} 1(b_i > x_i)\right] = 0.68$$

A2. Reservation prices are strictly decreasing in the amount of the MOIP ADSO that an officer would have served anyway

$$\frac{\partial x_i}{\partial r_i}(r_i, b_i) \le 0 \text{ for all } r_i, b_i$$

### We assume reservation prices satisfy the following

A3. An officer who would have served the entire 36-month ADSO anyway has a reservation price of zero  $\lim_{r_i \to 36} x_i \text{ is deterministic with value 0}$ 

A4. Reservation prices cannot be negative  $x \ge 0$ 

A5. Reservation prices can approach zero\*  $x_i \sim \text{such that (10th percentile value / 1st percentile value) > 2}$  $x_i \sim \text{such that 0 is within three standard deviations of the mean}$ 

\* To bound the distribution, but also plausible

### Plus two much stronger parametric assumptions

A6. Exponential distribution of reservation prices  $x_i \sim \text{Exponential}(\lambda_i)$ 

A7. Acceptance probability increases exponentially in RMST r $\lambda_i = \lambda_i(r_i, b_i; d) = -\frac{1}{b_i} \ln \left(1 - \exp(d(36 - r_i))\right)$ , where d < 0

#### Interpretation:

By A6, higher reservation price less likely than lower ones Degree that higher reservation prices less likely based on  $\lambda_i$ 

A7 sets  $\lambda_i$  to match the quantile function  $b = -\frac{1}{\lambda} \ln(1-p)$ where probability  $p = \exp(d(36 - r_i)) \in (0, 1]$ 

p percent of time, reservation price falls below  $-\frac{1}{\lambda}\ln(1-p)$ 

### Summary of estimation method

- 1. Train RPM-A to forecast survival curves for eligible officers immediately before the MOIP's implementation
- 2. Impute existing ADSOs of each eligible officer
- 3. Calculate RMST over the MOIP ADSO that each eligible officer would have likely served anyway
- 4. Find a distribution of reservation prices consistent with the acceptance rate (and other assumptions)
- 5. **Repeatedly sample** from that distribution to simulate the program many times
- 6. Compute mean rents and cost per service year gained

# Main Results

### RMST by bonus amount



RMST captures the number of months of the MOIP ADSO that officers would likely have served anyway.

Bin size = 0.5 months

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### Can draw RMST from various distributions

# Lower reservation prices are more likely as RMST increases (distribution becomes steeper)



CSRB amount = \$30,000

Fitted exponential decay constant d = -0.1027

### Mean reservation price by RMST and CSRB amount



### Mean economic rent by RMST and CSRB amount



# Service members most likely to accept a bonus generate the most in economic rent



Constant bonus amount = \$30,188

### Summary of results for 68% acceptance rate

Outcome among the Studied Population	Estimate
Total bonus cost	\$311.5 million
Total years of service gained	2,800
Bonus cost per year of service gained	\$110,000
Total rents paid	\$193.2 million
Share of costs that are rents	62.0%

# Sensitivity Analyses

# How robust are these results to changes in the underlying assumptions?

Reservation prices could be drawn from alternative distributions Gamma distribution as an alternative parametric specification  $x_i \sim \Gamma(\alpha, \lambda_i)$  $\lambda_i(r, b_i; d) = \frac{1}{b_i} Q^{-1} \left( \alpha, 1 - \exp(d(36 - r_i)) \right),$ 

where  $Q^{-1}$  is inverse of lower incomplete gamma

Scale parameter  $\lambda_i$  could be based on a single bonus amount

Expected acceptance rates may vary

#### Existing ADSOs may be underestimated

Deterministically or randomly add up to 2 years to existing ADSOs of captains who have completed their commissioning ADSO

# Share of costs that are rents varies with the shape parameter for the gamma distribution



Shape parameter values > 4.5 violate assumption A5

# Share of costs that are rents when scale parameter is based on equal bonus vs. \$25,000, \$30,000, \$35,00 bonuses



### Rents and costs as MOIP acceptance rate varies: Original exponential distribution assumptions

Outcome	60%	68% (Actual)	80%
Total bonus cost	\$274.9 million	\$311.5 million	\$366.4 million
Total years of service gained	2,250	2,800	3,650
Bonus cost per year of service gained	\$120,000	\$110,000	\$100,000
Total rents paid	\$166.1 million	\$193.2 million	\$239.0 million
Share of costs that are rents	60.4%	62.0%	65.2%

# Recommendations

# How could the Army use its limited retention resources more effectively?

Target individuals based on quality

- In 2007, there were few accessible measures of a captain's quality
- For instance, no "Potential Block Check" on officer evaluation reports for captains in 2007\*
- Army is now cataloging knowledge, skills, and behaviors and has other data to help identify quality

### Target individuals based on **propensity to exit** Target high performers who may be likely to leave

RPM-A helps to identify when an individual may be likely to exit

Archive data from the intervention to enable long-term studies

### To identify true **causal impacts**, enable variation

Implement a controlled trial (best) or an eligibility cutoff (distant second-best) \* DA PAM 623-3, 13 August 2007, p. 14, 21

# Backup

# Exponential distribution parameter $\lambda_i$ conditional on RMST



Exponential decay constant d = -0.1027



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