



SECONOMICS

# Agency Problems in Airport Security Regulation: Qualitative and Quantitative Evidence on the Impact of Security Training and Technology

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16th June 2014



Security Economics: Socio economics meets security



# Overview of our research

This paper is focused on the security of airports.

- ▶ Specifically, this paper addresses the various drivers of local security in an airport environment where the space of threats is considered to be relatively high.
- ▶ In this instance the Anadolu airport located in Turkey has provided a high level of access to security staff at all levels of seniority.
- ▶ Our approach involves constructing a game-theoretic model of the organisational hierarchy of an airport and then using this to guide a qualitative analysis of behaviour via semi-structured interviews of key participants.
- ▶ Our approach is designed to assist in the design of empirical experiments by identifying the marginal effects of incentive incompatibility of the various agents managing security in the airport environment.
- ▶ In this paper we try to focus on the effectiveness of various managerial approaches to aligning incentives and attempt to design models of optimal contracts for these agents.
- ▶ In the final section we motivate the proposed mechanisms, by use of semi-structured interviews.

# Some High Level Questions

- ▶ **Why are theoretical models important?**
  - ▶ The simple fact is that we need to start from some natural baseline model that is grounded in simple behavioural assumptions. *Law of parsimony.*
  - ▶ Good theoretical models have solutions that make specific predictions that can be easily tested and exhibit variation in outcomes with simple, well understood, adjustments to their structural parameters. *A simple model 'landscape'.*
  - ▶ Data driven models without any theoretical underpinnings are vulnerable to either missing important relationships or mining out relationships where none actually exist. *The rabbit hole problem.*
- ▶ **Why are principal agent problems important?**
  - ▶ Principal-agent (PA) models are a class of models that address incentive issues when the various participants exhibit incentive incompatibility. This set of models provides a rich framework for security problems when we need to contract out our security to others (e.g., TSA's low pay rate and high job turn-over rate).

- ▶ **Why are empirical experiments difficult?**
  - ▶ Data on security, in particular airport security, is relatively scarce or of poor quality.
  - ▶ The reliable data that does exist is usually not sampled from identical experimental conditions.
  - ▶ Hard to build a data driven model, that is trust-worthy, in these circumstances.
- ▶ **How can you map qualitative data to a quantitative model without data from experiments?**
  - ▶ Good quantitative models provide domains of parameters that can be used to guide to the basic trade-offs in game theory models such as the one we propose.
  - ▶ Qualitative data can be used to verify that these trade-offs exist, even if it cannot precisely identify their magnitude.

# Outline of Talk

- ▶ Our model.
- ▶ Setting of our interviews.
- ▶ Some high level results.
- ▶ Some concluding remarks.

# THE MODEL

## Major modelling ideas:

- ▶ We focus on a P–A game where the players are both on the security provision side.
- ▶ In our case study the principal (usually referred to in the feminine) is a government agency (hereinafter, referred to as “the government”).
- ▶ The agent(s) (referred to in the masculine) is a private firm or a worker conducting security on the principal’s behalf (hereinafter, referred to as “the employee”). For example, the agent can be considered as security staff (e.g., security guard and X-Ray screener) who is hired by an airport to meet the goals of the government.
- ▶ The overall objective of the principal is to write a contract that corrects any incentive for the agent to not apply appropriate *effort* to the tasks with which they have been entrusted.
- ▶ All our agents make decisions under a risk neutral measure.

# Description of Parameters

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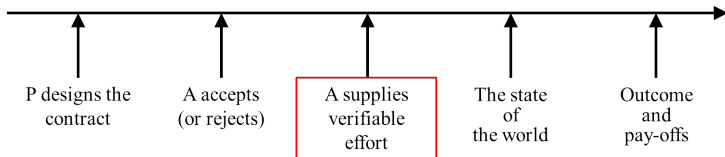
$a$	Employee's action of compliance with security rules.	$c(a)$	Employee's cost of action.
$x$	Informative signal from the employee's action.	$r$	A level of risk aversion.
$s(x)$	Reward function to observed action $x$ .	$\gamma$	Employee's 'pressure' from general training.
$\alpha$	Incentive rate.	$\nu$	General work standards.
$\beta$	Fixed wage.	$\rho$	The level of emotional satisfaction from general training.
$\pi_p$	Government's certainty equivalent.	$\eta$	Decreased cost from effective technical training.
$\pi_a$	Employee's certainty equivalent.	$\kappa$	Employee's 'pressure' from technical training.
		$\delta$	A desirable outcome from accurate security procedures.

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# The Mechanics of the Model

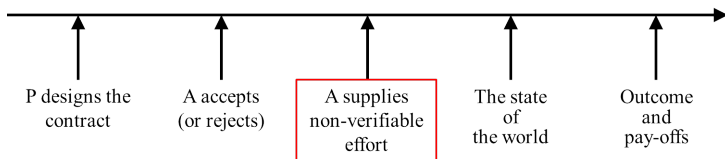
- ▶ Let  $a$  be the employee's action of compliance with security rules and  $x = a + \varepsilon$  be the observable informative signal from the action (i.e., outcome), where  $\varepsilon$  is zero mean noise.
- ▶ We consider a payoff function for the employee  $s(x)$ , which is assumed to be linear with an incentive rate  $\alpha$  and a fixed wage  $\beta$ .
- ▶ The pair  $\langle \alpha, \beta \rangle$  is referred to as an incentive scheme.
- ▶ Therefore, a contract is comprised of an incentive scheme together with the action,  $\langle \alpha, \beta, a \rangle$ .
- ▶ The employee is paid  $s(x) = \alpha x + \beta = \alpha(a + \varepsilon) + \beta$  after informative signal  $a + \varepsilon$  has been realized.
- ▶ The government's random net benefit can be defined as  $x - s(x) = (1 - \alpha)x - \beta$ .



- ▶ If the employee's action can be fully observable costlessly, the employee is paid a fixed wage  $\beta$  and the first-best contract is attainable.

# Creating Moral Hazard

- ▶ In reality, the employee's action is commonly unverifiable and unobservable, and his action is not contractable.



- ▶ In order to identify an optimal incentive scheme,  $\alpha^*$  and  $\beta^*$ , we first need to explore the employee's problem. His problem is to identify an optimal action level that can maximize  $\pi_a$  for given  $\alpha$  and  $\beta$ , this is denoted by  $\max_a \pi_a$  and gives the first-order condition  $\alpha = 2a$ .
- ▶ This condition shows that an optimal action level is only determined by an incentive rate  $\alpha$ .

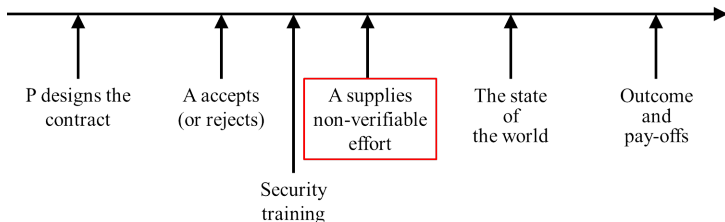
- ▶ Since we assume that the employee's action is not contractible, the problem for identifying an optimal linear contract for the principal can be solved by maximizing joint surplus  $\pi_a + \pi_p$  subject to the incentive compatibility constraint: i.e.,

$$\max_{\alpha, a} \pi_a + \pi_p \quad \text{subject to} \quad a \in \arg \max \pi_a.$$

- ▶ By combining these two optimisations we get a first-order condition  $1/2 - \alpha/2 - r\alpha\sigma^2 = 0$ .
- ▶ The condition implies that an optimal contract should be set to make the marginal net benefits of effort equal to the marginal costs of exposing the employee to risk.
- ▶ In the paper we demonstrate how the employee's perceived risk affects the contractual parameter. For example, the level of the incentive rate,  $\alpha$  decreases as the risk aversion,  $r$ , or the uncertainty,  $\sigma^2$  rises.
- ▶ Furthermore, the results show that, if incentive wage is not provided (i.e.,  $\alpha = 0$ ), the employee will not exert any effort (i.e., moral hazard).

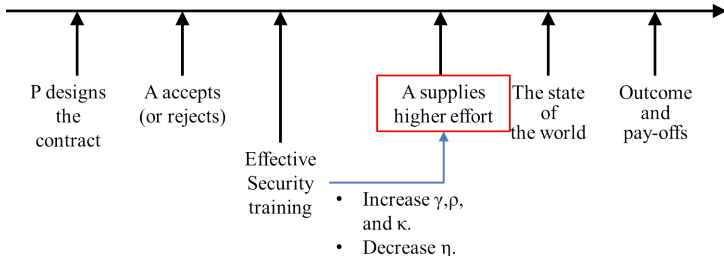
# Adding Security Training

- ▶ We will now add two types of security training to this setting: general security training and specific technical security training.



- ▶ As for the general security training, we add 'feeling'  $\gamma$  and 'satisfaction'  $\rho$  in the model.
  - ▶  $\gamma$  can be defined as feeling that general security training makes the employee comply with general security rules and procedures.
  - ▶  $\rho$  represents the level of emotional satisfaction that is fostered by the training program.

- ▶ As for the specific security training, we add 'pressure'  $\kappa$  and 'decreased cost'  $\eta$  in the model.
  - ▶  $\kappa$  is pressure felt by the employee to conduct specific security procedures accurately.
  - ▶  $\eta$  represents a decreased cost due to the increased effectiveness of specific security procedures.
- ▶ The solutions suggest that an effective general/specific training program might be able to mitigate the agent's moral hazard.



# Semi-structured interviews

- ▶ Calibration and validation of a P–A based model represents a challenge due to the variety of factors affecting the multifaceted relational system.
- ▶ Interviews with the people directly involved allows a researcher to gain an insight about why people behave the way they do.
- ▶ Three key features: a main topic, a data collection method, and a source of data.
  - ▶ Airport security training.
  - ▶ Semi-structured interviews, focusing on how training impacts incentives.
  - ▶ A group of interviewees that represent both the principal's and agents in this model.

## Participants in the semi-structured interviews

Role	Institution	Interview Date
Executive director responsible for safety	Anadolu	November 15, 2013
Board member for operations and regulation	Anadolu	November 15, 2013
Executive director responsible for safety	Anadolu	November 15, 2013
Board member for operations and regulation	Anadolu	November 15, 2013
Senior manager for governmental training program	DGCA	February 27, 2014
Senior manager for governmental training program	DGCA	February 27, 2014
Senior airport manager	HEAS	February 28, 2014
Chief of Security Operations	DGCA	February 28, 2014
Senior airport manager	Anadolu	November 15, 2013
Senior airport manager	Anadolu	November 15, 2013
Senior manager for airport training program	Anadolu	November 15, 2013

# Questions

INTERVIEW QUESTIONS – Anadolu Dissemination Event, 27<sup>th</sup>-28<sup>th</sup> Feb 2014

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## MAKE-OR-BUY DECISION

The first section of questions aims at collecting data about the dilemma between the make or buy decision related to the provision of training and security in airports of various size. Semi-structured interviews are designed to solicit information on outsourcing/insourcing issues in order to determine which are the main factors affecting this strategic decision.

**Airport Managers** (ex: Istanbul, Riga, Sarajevo, Tallin, Warsaw, Anadolu)

Training	Security
1) Who is responsible for training in your airport?	1) Who is responsible for security in your airport?
2) By whom is training provided in your airport?	2) Can you describe the organizational structure of the security staff in your airport? Which actors are involved? Roles/duties?

**Private security responsible[s]** (mostly from TAV Private Security Services. Istanbul, Ankara, Anadolu)

1) Which security roles does your private security company cover in the airport? Duties? Activities? (Mention at least 2)
2) Do you share your everyday work activities with other security agents? Do you have different roles/duties? (How is the interplay with the other security agent managed?)
3) Do you have a specific training in aviation security? (Different training programs for different security staff? How many hours? Provided by whom?)
4) Is your performance regularly monitored? Are security agents in charge with different roles differently evaluated? How? (Are they monitored on measurable outcomes? (ex: security guards and x-ray inspector should have different performance measures))
5) About the contractual relationship: a. Is it a long-term or short-term contract? b. Does the airport share sensitive information with you?
6) Have you ever experienced conflicts with the airport on the management of the security services? Ex?

3) Do you have the chance to decide to whom commit the delivery of training? a. If outsourcing: Why do you prefer this solution? Criteria? (Cost efficient, expert personnel, better control, ...) Do you have a "preferred" provider? b. If insourcing: Why do you prefer this solution? Criteria?	3) Do you have the chance to decide to whom commit the delivery of security services? a. If outsourcing: Why do you prefer this solution? Criteria? (Cost efficient, expert personnel, better control, ...) Do you have a "preferred" provider? b. If insourcing: Why do you prefer this solution? Criteria?
4) About the contractual relationship: a. How can you evaluate the quality of the outsourced/insourced provided training? Monitoring? (Formal and direct monitoring// informal and infrequent? Why?) b. Is it a long-term or short-term contract? c. Do you share sensitive information with the outsourced company?	4) About the contractual relationship: a. How can you evaluate the quality of the outsourced/insourced provided security? Monitoring? (Formal and direct monitoring// informal and infrequent? Why?) b. Is it a long-term or short-term contract? c. Do you share sensitive information with the outsourced company?
5) Have you ever experienced conflicts with the outsourced company? Ex?	5) Have you ever experienced conflicts with the outsourced company? Ex?
	6) Do you have an evaluation system for police staff as well?
	7) Who pays for security in your airport? (state/charges on passengers ticket)

## REGULATION AND FINANCING MECHANISMS

**Airport Managers** (listed above)

1) Do you think that the current regulation related to airport security appropriately fits your airport needs?
2) Customized vs. uniform regulation: which is more appropriate in your opinion? Why? Ex?



# Risk Perception in the Aviation Domain

## Does the incentive structure of the contract matter?

- ▶ “In case of security incident in a Turkish airport, the liable person is the governor. [...] For any security related damage, insurance are applied and indirectly airport operator is responsible for the final results.”  
⇒ **The government might not be able to design a contract that can make an employee bear costs caused by shirking.**
- ▶ “...guys working for these security companies (in an airport) have no other choices for working so they have to work there if they want to earn money, but the problem is that they are not motivated enough. Very difficult to train them. This is a general problem in Turkey, they do not earn a lot of money but they do a very critical job.” ANON.  
⇒ **A low level of compensation might prevent an airport from hiring and retaining qualified employees.**
- ▶ “... this personnel (security staff) could be a potential threat to the security of the airport.”  
⇒ **Employees’ activities are prohibitively costly to observe, and the airport cannot distinguish between reputable and disreputable employees.**

## Principal's View On Training

- ▶ “In airport every person has a role and a duty in aviation security, so we need to train all of them in order to provide total security. We have to train them in aviation security procedures, national and international as well.”
- ▶ “The security awareness training is for everyone in the airport because it is an indispensable part of airport security. On the other hand, training implementation has to be different for different roles; you cannot implement the same rules for cabin crew and ground service people or screening staff in security check points.”

⇒ **With incentive issues, effective training can motivate employees by increasing their intrinsic preferences on security.**

## Agent's View On Training

- ▶ “You cannot easily change the physical environment but you can change people. So we have to improve training, people's vision, give power to them, responsibilities and motivation, salary, values.[...] If you are more trained you feel more confident [...]”

## Perceived importance/effectiveness of training

- ▶ “We have good security devices. However, there are not enough security training agencies in Turkey particularly specialized in aviation security. They are not efficient, so even if we had more money to invest, it would be difficult to find a good training. Training is mandated but not enough. We have to pay for further training.”
- ▶ “Module 1 (i.e., general training) is provided in the classroom environment. Modules 2 and 3 (i.e., specific training) are carried out by on-the-job training and practical exercises; you have to show how the X-ray machine works and how to detect explosive materials.”
- ▶ “Only Modules 2 and 3 have this exam (for the renewal of the certificate) [...] For Module 1, staff has the refreshment every 3 years, but they have no exam.”
- ▶ “(General) Training, as it is, is boring, people are not motivated to follow it. They learn more while working (i.e., on-the-job training). Time is short and (classroom) lessons are boring. It is not very effective.”

⇒ **Increasing  $\gamma$  and  $\rho$  by general training might not be attainable, whereas increasing  $\kappa$  and  $\eta$  by specific training would be feasible.**

## Concluding Remarks

- ▶ We can only present a small snippet of the interviews, however the preceding quotes capture a significant them.
- ▶ Given the relative level of risk in the Turkish air transport sector, this appears to be a critical point. If the financial implication of creating incentive based contracts mean that a better rate cannot be transferred to the agents, then training does appear to be a source of remediation of risk.
- ▶ Is it possible to construct a treatment group for this effect and explore it empirically? The answer is effectively no, the ethics of creating control groups with different levels of pay and training make a properly calibrated experiment impossible.
- ▶ However, we can seek to identify changes in 'feeling', 'pressure' and 'satisfaction' gained from training and link this to security effectiveness. We indeed found some evidence of how different types of security training might affect employees' motivations on security.
- ▶ A hard task maybe just got a little easier.