Written Exam for the B.Sc. or M.Sc. in Economics winter 2015-16

Organizations and Incentives

Final Exam/ Elective Course/ Master's Course

January 20, 2016

(3-hour closed book exam)

Sketch for solution

Note: The following illustrations are a sketch of how to solve the exam questions, rather than a full-fledged "solution manual". Some derivations of results are omitted for brevity and some responses only exemplify possible solutions to the questions (in both cases, further details can be found in the lecture notes of the respective sections).

Question 1 (33%):

a) Assume that the agent has accepted a contract with salary *s* and commission rate *b*. Which effort level does he choose?

The agent maximizes his utility w.r.t. e:

$$\max_{e} u(w, e) = s + be - \frac{1}{2}rb^2\sigma^2 - \frac{1}{2}c\,e^2$$

FOC (incentive constrain, IC): $b - c\,e = 0$

The agent's optimal effort is thus $\qquad e^* = \frac{b}{c} = \frac{b}{2}$

b) Which condition needs to be fulfilled for the agent to be willing to accept a contract offer with salary *s* and commission rate *b*?

In order to make the agent accept the contract, the contract has to fulfil the agent's participation constraint (PC). The PC is given by:

$$u(w, e) \geq \underline{u}$$

$$\text{i.e., } s + be - \frac{1}{2}rb^2\sigma^2 - \frac{1}{2}c\,e^2 \geq 0$$

$$s \geq \frac{1}{4}b^2 + e^2 - be$$

c) Determine the first-best level of effort, i.e., the effort level that maximizes the sum of the principal's payoff and the agent's utility. Which commission rate b would induce the agent to choose this effort level (according to your result from part a)?

$$\max_{e} s + be - \frac{1}{2}rb^2\sigma^2 - \frac{1}{2}c\,e^2 + e - s - be$$

$$FOC: b - c\,e + 1 - b = 0$$

$$\text{yielding first best effort} \qquad e^{FB} = \frac{1}{c} = \frac{1}{2}$$

Comparing this expression to part a) shows that, in order to make the agent exert first-best effort, the commission rate has to be equal to $b = 1$.

d) Consider now the principal's problem. Which commission rate b will she offer to the agent? What is the resulting effort that the agent exerts in equilibrium?

The principal maximizes her payoff subject the incentive constraint (IC) and the participation constraint (PC):

$$\max_{e,s,b} e - s - be$$
$$\text{subject to (IC): } b - c\,e = 0$$
$$\text{and (PC): } s + be - \frac{1}{2}rb^2\sigma^2 - \frac{1}{2}c\,e^2 \geq 0$$

Solving the constrained optimization problem, e.g., via Lagrange method (omitted here; see lecture notes for detailed derivation) yields

$$b^* = \frac{1}{1+cr\sigma^2}$$

$$\text{or } b^* = \frac{1}{2}$$

The resulting effort in equilibrium (see part a)) is thus $\quad e^* = \frac{b^*}{c} = \frac{1}{4}$

e) How does the optimal commission rate change if $r = 0.5$ instead of 0.25? How does this affect A's effort in equilibrium?

Inserting $r = 0.5$ instead of 0.25 into the expressions for b, e derived in part d) yields

$$b^{*\prime} = \frac{1}{3}, e^{*\prime} = \frac{1}{6}$$

f) Explain what is meant by the "tradeoff between incentives and insurance" in principal-agent problems. You can use your answers to parts a) – e) to illustrate your response (but you are also encouraged to respond if you have not answered all of the above questions).

From a pure <u>incentive</u> perspective, it would be best to "sell the firm to the agent" and leave the agent all the net revenue from production, by setting b=1 (and s<1). If the agent reaps the entire gains from production (b=1), he has incentives to select the efficient (first-best) level of effort, as shown in parts a) and c).

With b=1, however, the agent faces a lot of random fluctuations in income: all shocks in y are directly transmitted to the agent's earnings w (through $by = b(e + \varepsilon)$). The agent dislikes this because of risk-aversion. In order to make the agent accept a contract featuring high levels of b, the fixed salary component s therefore has to be relatively high, as illustrate in part b (put differently, the price at which the principal could "sell the firm" to the risk-averse agent would be relatively low).

Since the agent is risk averse and the principal is risk-neutral, it might be better for the principal to offer the agent some <u>insurance</u> against income fluctuations, by selecting a relatively high fixed salary s and a relatively lower commission rate b. However, offering the agent full insurance (i.e., setting b=0, s>0) would eliminate all performance incentives for the agent, resulting in e=0 as shown in part a).

The second-best contract(s) derived in parts d (and e) is the one that optimally solves this <u>tradeoff</u> between providing incentives and insurance. If the agent is more risk averse (e.g., r = 0.5 instead of 0.25 as illustrated in part e), the optimal contract features a lower commission rate $b^{*\prime}<b^*$. This implies more insurance for the agent, but lower incentives for effort provision, as illustrated by $e^{*\prime} < e^*$.

Question 2 (25%):

It is often argued that compensation schemes do not only affect workers' performance incentives, but that they can also have "selection effects" (or affect "worker sorting").

a) Explain briefly what is meant by "worker sorting" and the selection effects of compensation schemes.

- *Workers differ in terms of personal characteristics such as productivity, personality, or preferences (e.g., risk preferences, social preferences, competitive inclination).*
- *Because of these differences, different types of workers might find different compensation schemes more/less attractive.*
- *For examples, a compensation scheme with strong focus on individual performance pay might be particularly attractive for more productive / less risk averse / more competitive agents. Other types of workers might feel more attracted to different compensation schemes, e.g., with stronger focus on fixed salary or group-level pay.*
- *The characteristics of the compensation scheme therefore affects what type of workers want to take up a given job, i.e., which type of worker "sorts" or "selects into" a given job.*

b) Why is it difficult to disentangle the incentive and selection effects of compensation schemes empirically? Describe at least 3 factors that complicate the empirical identification of sorting / selection effects.

To disentangle the incentive and selection effects, ideally we would want to observe all potentially relevant individual characteristics of the agents, their sorting decision, their performance under the selected compensation scheme, and their performance under other (counterfactual) compensation schemes.

In practice, various factors complicate the empirical identification of sorting effects:
- *Lack of counterfactual observations: firms adopt compensation schemes endogenously, workers endogenously sort into firms.*
- *Measurement of incentives: firms often use mix of incentives. Hard to observe exact incentives that worker faces.*
- *(Precise) measures of workers' productivity, effort, ability, etc. are often not available*
- *Preferences, inherent productivity, and personality traits that can matter for sorting decision are typically not observed by the econometrician*
- *Sorting takes time: when to evaluate the incentive/sorting effects?*
- *...*

c) Throughout the course, we have discussed various studies that have analyzed the selection effects of compensation schemes. Consider two of these studies and describe how the authors of the studies have tried to tackle the challenges you mentioned in part b). To do so, describe the empirical strategies of the papers and explain how the authors use their approach to analyze sorting / selection effects. Do the studies differ in the degree to which they can address the different challenges?

Possible studies that we have discussed in class: Lazear (2000), Niederle and Vesterlund (2007), Dohmen and Falk (2011), Bartel et al. (2013), Carpenter and Gong (2015)

Sketch of solution for the example of Dohmen and Falk (2000)
- *Use lab experiment to study sorting. Key ingredients of their empirical strategy to analyze sorting:*
- *First, measure productivity for all participants under the same incentive scheme: tackles measurement problems regarding ability/productivity and (at least partially) lack of counterfactual observations.*
- *Second, directly measure sorting decision: each worker can decide between two different incentive schemes. The available schemes are exogenously given by the experimenters: together with previous (and subsequent) steps, this allows to identify which type of worker sorts into which compensation scheme.*
- *Third, measure performance of workers under the selected incentive scheme: measure incentive effects, conditional on sorting.*
- *Finally, throughout the experiment, they also measure risk attitudes, social preferences, (beliefs about) ability: tackles problems of unobserved variables that matter for sorting decision.*

Example of a challenge that lab approach allows to address better than other approaches: possibility to elicit preferences and other personality characteristics that are typically unobservable in field data (e.g., Lazear 2000).

Question 3 (29%):

a) Why is it generally difficult to determine whether an individual's behavior is influenced by her peers (i.e., whether there are peer effects)?

Observing that individual A behaves similar as peer P does not necessarily imply that there is a behavioral spillover from P to A (i.e., a peer effect):
  - *Peer outcomes are often determined simultaneously. Does P influence A or vice versa?*
  - *Peer groups are endogenous (and typically no counterfactual observations). Does similarity in behavior reflect sorting of people with similar personal characteristics into the peer group?*
  - *Do peers just face similar environments / local attributes that influence behavior of both P an A?*

b) The paper "Peers at Work" by Mas and Moretti (AER 2009) uses scanner data from a supermarket chain to study peer effects.
  - Briefly summarize the basic setup of their study and
  - explain Mas' and Moretti's empirical strategy for identifying peer effects.

  - *They use scanner data from supermarket chain: observe transactions from different stores, covering a relatively long time period and almost 400 workers.*
  - *Workers receive a fixed hourly payment.*
  - *Working faster has positive externality on other workers (due to shorter queues).*
  - *They observe individual-level high-frequency measure of current productivity: average number of items scanned in ten-minutes period.*
  - *M&M's identification strategy:*
    o *Use longitudinal structure of data set to estimate the permanent component of each worker's productivity θ_i (basic assumption: workers with a high θ_i are on average more productive than workers with a low θ_i)*
    o *Exploit changes in workforce composition during a worker's shift: regress changes in individual i's current productivity on changes in permanent productivity of co-workers who are present at time t (and controls).*

c) One important concern is that the observed peer effects in their study may be spurious. This could, for example, be the case if more productive workers worked at times of the day when demand was higher (e.g., in order to shorten the queues). Explain briefly how the authors address this concern econometrically.

M&M test whether highly productive workers are more (less) likely to enter (exit) during times where customer volume is high:
  - *Use longitudinal data to predict demand fluctuations over course of the day.*
  - *Estimate likelihood of high / low productive workers entering at times where demand is predictably high (and find no evidence for strategic scheduling of highly productive workers).*

d) Mas and Moretti also investigate potential channels through which peers could affect each other's behavior.
- Sketch (at least) two of these channels.
- Explain which information Mas and Moretti use to distinguish between the channels, and how they use it.

Possible channels
- *Social pressure, e.g. shame, (fear of) informal sanctions*
- *Pro-social behavior, e.g., "contagious enthusiasm", guilt*
- *Knowledge spillovers*

M&M use location and observability of workers at different counters / cashier lines to distinguish between the channels
- *If social pressure is the main force: spillovers should mainly occur when low-productivity worker is observed by high-productivity worker*
- *If "contagious enthusiasm" is the main force: spillovers should occur mainly when (low-productivity) incumbent worker observes highly productive entrant*
- *If knowledge spillovers are the main channel: observability not have no asymmetric effects. Rather, overall distance between peers should matter*

Question 4 (13%):

Consider the following statement:

"The fact that some firms pay their salesforce only commission rates in the range of 2-3% of a salesperson's sales volume shows that these firms do not know how to set incentives right. In order to be motivated to work hard, it is vital that an employee realizes some immediate returns to her efforts in her pocket. At such low commission rates, an employee is certainly not motivated to work as hard as he could, so these rates can ultimately also not be optimal for firms. Employers finally have to understand that paying their employees decent wages is not a zero-sum game, but can be mutually beneficial for the firm and its employees."

Please comment on the statement. Which parts of it do / don't you agree with? Explain your responses based on the theoretical models and / or empirical evidence discussed throughout the course (you can also make use of your responses to the other exam questions).

- *Sales volume does not say how much net revenue the salesperson generates for the firm (the latter is what matters for optimal commission rate in simple P-A model with linear contracts, see Question 1). 2% on sales volume could imply a much higher commission on the resulting net revenue.*
- *Knowing the commission rate alone is not sufficient to evaluate performance incentives that a worker faces. Oftentimes, compensation schemes are a mix of different components which might all generate performance incentives for the agent, e.g., end-of-year bonuses, fixed salary, prizes for sales competitions, prospects of being promoted. To evaluate whether "firm sets incentives right", we would need to know the whole compensation scheme.*
- *Performance incentives do not only depend on immediate, financial returns. Agents could also be motivated through future rents (e.g., dynamic incentives in repeated games, promotions), through intrinsic motives, etc.*

- *Incentivizing agent to work "<u>as hard as he could</u>" is generally not efficient and / or optimal from firm's perspective (e.g., have to take effort costs into account, see Question 1).*
- *"<u>Decent wages</u>" can sometimes indeed be mutually beneficial, as illustrated for example in the literature on fairness and gift exchange.*