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Introduction

At the beginning of the paper, it is reasonable to settle our insight in the proper cognitive and behavioural dimensions (Kreps, 1990). Therefore, we assume that economic agents considered in the following analysis are **completely rational** and **behave opportunistically** (Hendrikse, 2003).

The first assumption that regards complete rationality is much more heroic than the second one (behavioural assumption). Complete rationality means that agents always have the cognitive capacities large enough to handle a particular problem (Hendrikse, 2003). That is, they can grasp and solve the problem immediately and the level of complexity of the case is just enough for a given agent. Heiner (1983) believes that for a completely rational decision maker the ratio between the cognitive capacities and the complexity of the problem is close to one. This assumption is very often not realistic (see e.g. Whalley, 2005), but it is still maintained in the following analysis (for formal convenience and tractability of the proposed mathematical model).

At the operational level complete rationality assumes unlimited computational capacity of the human brain. Moreover, complete rationality excludes feelings and emotions from human judgment and decision-making. Therefore, many social scientists have proposed alternatives to complete rationality concept (see e.g. Simon, 1982; Becker, 1962; Thaler, 1995; Camerer, Lowenstein and Prelec, 2003). The major alternatives are then: (1) limited (bounded) rationality and (2) procedural rationality.

Limited rationality (bounded rationality) is relevant when the cognitive capacities of the decision maker are insufficient to grasp the whole complexity of the problem. It is not possible to handle all aspects of a given problem when a decision has to be made, because behaviour is intentionally rational, but only limitedly so (Hendrikse, 2003; Simon, 1961). Simon argues (1982) that individuals can only process a limited amount of information and, in real life situations, they let their feelings and emotions override logic. In practice, people take shortcuts when a decision has to be made (Whalley, 2005).

Procedural rationality is relevant when the complexity of the problem is significantly larger than the cognitive capacities of the decision maker. Then the behaviour is typically governed by a rule of thumb. This type of rationality is relevant in environments where the speed of adjustment is low (Hendrikse, 2003).

Psychologists and economists differ drastically in their understanding of theories regarding human cognitive capacities (Rabin, 1998). Psychologists usually start with limited rationality (or procedural rationality in very complex environments) and allow the specific context to play a role. This creates framework for analysing (mostly qualitatively) human biases in decision-making, links between reasoning and emotions and functioning of various mind heuristics. Economists, on the contrary, construct normative, quantitative theories that perceive an individual as an optimising device.

This paper attempts to unify psychological and economic approaches. Whereas, in terms of introduced cognitive assumption, the paper remains to be rigorously economic (complete rationality holds), in terms of introduced behavioural hypothesis the article tends to be psychologically valid (agents are opportunistic).

Opportunistic behaviour (behavioural assumption) – this assumption is rather natural. Employees of the enterprise are very often unlikely to behave idealistically (i.e. in the interest of the whole organization; see Kreps, 1990) or in a perfectly self-interested (selfish) way (which means fully egoistically, honestly and reliably; see Kreps, 1990).

The psychological intuition is that many employees behave opportunistically, so they often cheat or tell only part of the truth (Hendrikse, 2003). An opportunistic agent is also very likely to shirk fulfilling work duty or obligation (Tirole, 1988). This likelihood is even greater when the responsibility for a given task is spread across hierarchical structure (this thesis will be discussed further). An opportunistic behaviour may lead to decision chain formation and herd appearance within organization, which then results in the company entering wrong business projects. This thesis will be examined in detail later on (section 2).

To conclude the above concise discussion of introduced assumptions let present the cognitive and behavioural underpinnings of the following model graphically (see Table 1).

TABLE 1. **Basic cognitive and behavioural assumptions concerning the economic agent in the presented model**

	Behavioural hypothesis			
		Opportunistic	Selfish	Idealistic
Degree of rationality	Complete rationality	The model (see section 2)		
	Limited rationality			
	Procedural rationality			

Source: Kreps, 1990.

In addition, allow the remark that possible organizational inefficiencies (shown in the following herd model) occur not because employees and managers are not able to handle the considered problem properly (remember that complete rationality assumption holds), but they simply shirk doing it.

The herd model

Let start the analysis with a very basic version of the model. Imagine that the hierarchy in a given organization is very flat (e.g. in a small firm) and we have only two agents who decide whether enter or reject the investment project. We may call them supervisor (principal) and subordinate (agent). For formal convenience, we denote the supervisor as actor B and the subordinate as actor A.

Actor A is closer to the market, so she/he can easily directly observe economic effects of investment adoption in the given market. Actor B is higher in the organizational hierarchy, i.e. she/he is more distant from the market of investment adoption. Therefore, she/he could be worse informed about potential and real market effects of investment adoption. However, she/he is truly interested in making proper (optimal) investment decisions from the perspective of the whole organization.

Both supervisor and subordinate are responsible for investment project evaluation. Let say, actor A is responsible for the preparation of a feasibility study, while actor B is obliged to approve or disapprove a given project.

Suppose that each project can be valued as follows:

$$\theta^A(\Omega^A) \in U[-1,1]$$
$$\theta^B(\Omega^B) \in U[-1,1]$$

which means that valuation of a given project (θ) both for actor A and B is uniformly distributed from –1 to 1[1]. Valuations depend on information sets of actor A and B respectively[2]. Intuitively, we may identify the above valuations with NPV[3] assessments of the investment project prepared by actor A and B respectively. The project is economically justified when NPV is positive (or equal to zero if applicable).

Moreover, we plug hidden characteristics[4] concept into the model (Mankiw, 2008). Suppose that valuations done by both actors belong to different information sets (i.e. ($\theta^A \subseteq \Omega^A$, $\theta^B \subseteq \Omega^B$,)). The information set of actor A is usually richer due to a shorter distance from the market, which delivers loads of information that should be taken into account by the project appraisal. The information set of actor B includes the fraction of information available for agent A and some specific information available only at the higher stage of organizational hierarchy.

The supervisor treats the quality of the project assessed by actor A as a hidden characteristic[5]. The supervisor knows that the agent could shirk and therefore her/his evaluation brings little information about the real quality of the considered project. Therefore, valuation delivered by actor A may be just a suggestion taken into consideration and not a complete decision rule for actor B[6].

Let now present an extended version of the herd model. We well hereby discuss a variant of the model, in which subordinates are likely to shirk, but "the last in the row" supervisor (the last decision maker) is not. It means that the last decision maker does not shirk. Let say, "the last in the row" decision maker behaves like the owner of the company. The others may shirk.

We start the analysis with two players only. Further, we will focus on the longer decision chain consisted of *n* players (general case). Actor A is a subordinate and she/he moves first. Her/his task is to prepare a fundamental economic assessment of the considered investment. Actor A will accept the investment project only if $\theta^A(\Omega^A) \geq 0$. That is, actor A will accept the project only if her/his valuation (NPV measure) is positive (or equal to zero).

If this is the case, the project is transmitted higher within the organizational hierarchy till the supervisor is reached in the decision chain. The supervisor knows that employees behave opportunistically, so they may do their best or they may simply shirk. Thus, the decision rule for actor B can be written as follows: $E[\theta^A \mid \theta^A(\Omega^A) \geq 0] + \theta^B(\Omega^B, \theta^A) \geq 0$, where $E[\cdot]$ is the expected real NPV measure from the first stage.

The supervisor occurs in the decision chain only if $\theta^A(\Omega^A) \geq 0$, otherwise, the project is rejected at the first stage and the game is at the end. Therefore, the decision rule for agent B should be equipped with conditional probability (i.e. $E[\theta^A \mid \theta^A(\Omega^A) \geq 0]$).

The supervisor treats valuation delivered from the first stage as a suggestion only. The supervisor expects a real first-stage NPV measure as if she/he were in the first stage. Expectations of the supervisor are rational due to a complete rationality assumption, so no systemic errors are made by the real first-stage NPV determination. In addition, the supervisor prepares her/his own valuation based on the information available for her/him only ($\theta^B(\Omega^B, \theta^A)$). Agent B treats the delivered value (θ^A) as an additional piece of information, let say, suggestion only. This additional piece of information can be interpreted as a signal[7] that should be taken into consideration by actor B. The sum of these two valuations (expected and deterministic) constitutes the decision rule for actor B. The project will be then accepted within the organizational hierarchy if the sum of the considered valuations is positive (or equal to zero).

Let us remark that the distribution support of the project evaluation is an increasing function of the number of considered players in the organizational hierarchy (i.e. decision chain). The support of agent A, just at the beginning of the game, is $[-1,1]$. The support of A and B (two players' game) is $[-2,2]$. The distribution support is then growing steadily and symmetrically along with the number of players. However, the decision rule always remains the same (no matter how many players we have), i.e. the positive[8] sum of all valuations means the acceptance of the project.

For simplification make notice that $E[\theta^A | \theta^A(\Omega^A) \geq 0]$ is equal to 1/2, because we work on the uniform distribution set-up. Therefore, the decision rule for actor B can be simplified and depicted as $\theta^B(\Omega^B, \theta^A) \geq -\frac{1}{2}$.

So far, we have determined decision rules in the model with two players only. This is, however, the simplest case. In reality, hierarchical structures in business are definitely more complicated and more actors are involved. Therefore, we now shift the model a bit. There are added successive actors.

This is not a technical paper. Therefore, we will skip step-by-step derivation of a decision rule for actor i ($i = 1, ..., n$[9]) and plug the solution directly[10]. Besides, the derivation is analogous to the two players' game.

Decision rule for the third ("last in the row" in this case) actor (let say C) is as follows: $\theta^C(\Omega^C, \theta^A, \theta^B) \geq -\frac{1}{2} - \frac{1}{4}$. Decision rule for the fourth ("last in the row" in this case) actor (D) is then as follows: $\theta^D(\Omega^D, \theta^A, \theta^B, \theta^C) \geq -\frac{1}{2} - \frac{1}{4} - \frac{1}{8}$.

It appears that the right-hand side of the above inequalities constitutes a mathematical sequence. This sequence can be expressed as follows: $-1+\frac{1}{2^{i-1}}$ for $i = 1, ..., n$. Observe now that $\lim_{i\to\infty}(-1\frac{1}{2}+\frac{1}{2^{i-1}}) = -1$, so decision rule for the supervisor i („last in the row" in general, infinite case) may be given in the following way: $\theta^i(\Omega^i, \theta^A, ..., \theta^{i-1}) \geq -1$. This formula constitutes the solution of the proposed herd model[11]. Interpretations of the above results and implications are discussed in the next section.

Discussion and model implications

Scharfstein and Stein (1990) analysed the investment behaviour of managers who cared about their high esteem within organization. It turns out that it is optimal for a manager to imitate the investment decisions of others, despite the fact that a prticular manager knows that another decision could create more value for the company. High-ability managers usually base their decisions on the collected economic data (empirical facts). The result of the investment project can nevertheless be poor due to misleading information, insufficient information, low-quality information or simply bad luck (random factors).

Managers are certainly aware of this possibility and thus they take the decisions of others into account in the investment decision processes. It results in inefficient information processing and behavioural herding. Deviant behaviour is viewed as being more likely with a bad manager. A wrong decision for a specific manager is less bad for her/his esteem in organization when others do the same. It implies that a manager does not want to start a project based on her/his own information, but starts it based on the decisions of others (see also Hendrikse, 2003). This phenomenon is called **organizational herd behaviour**.

Obviously, the idea behind having a company's project evaluated by various actors is that each one collects different information, knowledge and experience. In the presented model, however, it has turned out that certain constraints are associated with such organizational decision-making processes. For example, if career, esteem or reputation issues play a role, one can make a decision dependent on the choice of others. Moreover, one can simply copy the choice of the previous players because of opportunism (shirking).

One way to prevent these organizational inefficiencies is to make those with the strongest career interests choose first. According to Hendrikse (2003) 'people concerned about their career are usually young managers, (…) they usually do not occupy the highest functions in the organization. It is therefore advisable to have **bottom-up** instead of **top-down** information flows in organizations'.

Let us now draw your attention to some direct implications of the presented herd model. These contributions will be pointed out and shortly discussed.

Implications

1. It appears that herd occurrence is more probable within vertical organizational structures than horizontal ones. The longer the decision chain (organizational hierarchy) is, the more probable herd behaviour is. Mathematically, we may show that $\lim_{i\to\infty}(-1\frac{1}{2}+\frac{1}{2^{i-1}})=-1$. This means that the decision rule of the supervisor i converges to $\theta^i(\Omega^i, \theta^A, \ldots, \theta^{i-1}) \geq -1$. As we know, -1 is the lowest possible project assessment that can be given by an agent. It means that in "infinitely long" organizational structures consisted of opportunistic agents each project will be approved no matter what its economic quality is.

Obviously, real organizations are not "infinitely long", so some projects will be rejected. The fraction of rejected projects could be, however, unjustifiably small due to herd behaviour formation. Herd behaviour leads then to many inefficiencies in company's management. Companies may enter too many risky, economically unjustified investment projects, sink valuable resources in them and hazard the future of their businesses.

2. The herd forming process is harder to interrupt at the further decision stage (higher in the organization) than at the beginning (at the bottom of organizational hierarchy). This means that along with moving higher in the organizational hierarchy the herding bias is self-enforcing. Therefore, it is reasonable (from the viewpoint of the owner of the company) to have at the bottom of the hierarchy people whom she/he may trust. Such people probably do not shirk due to their internally accepted values and trust-based relations with the owner. Therefore, they are highly probable to transmit true valuations further in the decision hierarchy. Moreover, it could be desired by the owner of a business to have motivated people at the bottom of the managerial line. Such people probably do not shirk in order to signal their high working quality.

3. Under considered circumstances, **horizontal organizations** can function better than a vertical ones (horizontal structures seem to be less prone to herd behaviour formation than vertical ones). In horizontal structures herd behaviour is less likely to exist, because actors may quarrel, ask for explanation, verify, and clarify their doubts with each other (so **information asymmetry between agents can be greatly reduced**).

Extensions

The presented model can certainly be developed. We may consider the possibility that "the last in the row" decision maker does not care much of the prosperity of the led company (the case where "the last in the row decision maker" is also opportunistic). Such set-up of the model should be thoroughly examined.

Moreover, the case of trust and reputation can be here deeply looked into. If the mutual trust is present in the organization and this trust is not spoiled by the employees' misbehaviour, many negative decision biases and organizational externalities are unlikely to happen. Such companies (equipped with internal trust) are called dense social capital companies. The analysis of the role of social capital (Coleman, 1988) in organizations and its influence on internal information flows and knowledge sharing is definitely worth carrying out.

Notes

[1] Segment [-1,1] is a distribution support in the given case.

[2] Information sets are denoted by omegas for agent A and B respectively.

[3] Net present value, the measure of investment project evaluation (Dayananda et al., 2002).

[4] Hidden characteristic is an example of information asymmetry. For instance, a seller of a used car knows more than the buyer about the car's condition and quality. The uninformed party (the buyer) would like to know the relevant information, but the informed party (the car seller) may have an incentive to conceal it.

[5] Due to lack of the appropriate information the real quality of the considered project is unknown for the supervisor.

[6] If actor B treats the delivered assessment as a complete decision rule the model is trivial and out of deeper interest.

[7] The idea of signaling was originally proposed by Michael Spence. In a situation with information asymmetry it is possible for people to signal their quality or the quality of their work (Spence, 1973).

[8] Or equal to zero.

[9] Where *n* stands for the number of decision makers in the organizational hierarchy.

[10] Calculations are, however, available upon request.

[11] The similar herd model is discussed by Gale (1996), but in the different, macroeconomic context.

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