A Theory of Explicitly Formulated Strategy

Eric Van den Steen*

May 3, 2012

Abstract

When a CEO tries to formulate 'a strategy', what is she looking for? What exactly is 'a strategy', why does it matter, and what are its properties?

This paper defines an explicitly formulated 'strategy' as the '*smallest set of choices and decisions sufficient to guide all other choices and decisions*,' which formally captures the idea of strategy as a plan boiled down to its most essential choices. I show that this definition coincides with the equilibrium outcome of a game where a person can – at a cost – look ahead, investigate, and announce a set of (intended or actual) choices to the rest of the organization. Strategy is also – in some precise sense – the smallest set of decisions that needs to be decided centrally to ensure that all decisions are consistent (by giving a clear direction).

The paper analyzes what characteristics make a decision 'strategic' and when and how having a strategy creates value, including when a strategy 'bet' can create value. It shows how understanding the structure of strategy may enable a strategist to develop the optimal strategy without a comprehensive optimization. And it derives some broader organizational implications.

JEL Codes: D70, L20, M10

1 Introduction

Judging from the more than 70,000 management books on the topic (Kiechel 2010), strategy is an issue of great interest to business. But strategy – in its everyday meaning – plays a role far beyond business: an economic zone may want a strategy to deal with a financial crisis; the military hopefully has a strategy to win a war.[1] Etymologically, strategy (στρατηγια) refers to the issues specifically under the authority of the army's overall commander, thus making it a defining responsibility for the leader or CEO. But what is 'a strategy'? What does it look like and why does it matter?

This paper develops a formal economic theory of explicitly formulated strategy – in its everyday meaning as a project or business strategy – and uses it to answer questions such as : Which choices and decisions are 'strategic'? What is the value of a strategy? I study these questions in a generic decision setting, going beyond a business context. The theory is not intended, however, as exclusive or all encompassing: it focuses on particular dimensions to provide useful insight into the nature and role of strategy.

*HBS (evandensteen@hbs.edu). I'm very grateful to John Roberts and Bob Gibbons, both for their input on this work and for their overall guidance and support. This paper would also not have existed without my HBS Strategy colleagues and without my students, who both made me think deep about strategy (from very different angles) and provided (resp. explicit and implicit) feedback on the ideas. I need to thank especially Bharat Anand, Ramon Casadesus-Masanell, David Collis, and Jan Rivkin for many conversations that influenced my thinking on this issue. I also thank Joshua Gans, Hanna Halaburda, Tarun Khanna, Hongyi Li, John Matsusaka, Michael Powell, Birger Wernerfelt, Tim Van Zandt, and the seminar participants at LSE, MIT, NYU, University of Rochester, University of Toronto, USC, Washington University, and the HBS Strategy brown bag lunch for their comments and suggestions. This paper and 'The role of leaders in strategy formulation' are respectively the first and second part of the earlier working paper 'A theory of strategy and the role of leaders in it.'

[1] In the body of the paper, I will use the term 'strategy' always in its everyday sense, rather than its game-theoretic sense. Whereas the proofs use both meanings, it will be clear from the context which meaning is intended.

The analysis starts from a formal definition that captures the idea of 'strategy as a plan' in very concrete terms that permit a formal analysis (and provide a concrete perspective). The starting point for the definition is the question what characterizes an 'absence of strategy'. The typical setting where people say that an organization 'lacks a strategy' is when the organization takes a number of actions that may each make sense on their own but that do not make sense together, i.e., that lack a unifying logic. Strategy, like a plan, thus ensures that all decisions fit together. This fits the Oxford Dictionaries Online's definition of strategy as 'a plan of action designed to achieve a long-term or overall aim,' Merriam-Webster's definition as 'a careful plan,' and Mintzberg's (1987) statement that 'to almost anyone you care to ask, *strategy is a plan* [emphasis in original] – some sort of consciously intended course of action, a guideline [...].'[2] As a plan, the purpose of strategy is to guide future choices, actions, and decisions towards some objective.

But a strategy is not a detailed plan of action or a comprehensive set of choices and decisions; it is a plan of action boiled down to its most essential choices and decisions. To capture that formally, I define a strategy as the '*smallest set of – intended or actual – choices and decisions sufficient to guide all other choices and decisions*' (or, more concisely, the 'smallest set of choices to guide all other choices').[3] Strategy thus provides each decision maker with just enough of the full picture to ensure consistency. The choices and decisions in a strategy may sometimes be very concrete – such as 'using exclusively Airbus A320 airplanes' – but are often high-level choices – such as a choice of target customer or product scope – that then serve as guides or objectives for the rest of the organization. A manufacturer's strategy, for example, may be to 'serve price sensitive US customers with a simple standard design, using mass assembly of outsourced components, sold through mass retailers, and with bare-bones service and support'. These few core choices then guide the organization. This definition focuses on the function of strategy, compared to the descriptive approach more common in the literature. Section 3 and 6 discuss in more detail the relationship to the literature, including to the idea of 'realized' or 'emergent' strategy (Bower 1970, Mintzberg and Waters 1985).

To give more texture to this definition, I start the paper by showing that the definition coincides with the equilibrium outcome of a game that captures a typical ('planned') strategy process – as we often see it in a consulting team, in a firm, or in the classroom – where people take a step back, collect information, and design a 'grand plan'. Consider a setting where a group of people are engaged in a common project and each person must make a choice or decision that affects the project's outcome. Each person has 'local' information about her own decision and how it interacts with others, but knows little or nothing about the others' decisions. If left to their own devices, the piecemeal or trivial outcome results: each decision is optimal on a standalone basis but there is a lack of alignment across decisions. People would say that 'this firm doesn't have a strategy.' I then allow one person, the strategist, to – at a cost – collect information and announce a set of choices or decisions. In equilibrium, this person will announce exactly an optimal 'strategy' as defined above: the smallest set of choices sufficient to guide all other choices to the objective. While not surprising, this result is important because it links this definition of strategy with a typical explicit strategy development process where people take a step back, collect information, and design an overall plan. The model therefore provides a transparent logic for 'a strategy', which is useful to explain and to analyze the concept. And it shows that a strategy as defined here is also – in some very precise sense – the smallest set of decisions that needs to be decided centrally to get consistency, tying

[2] Mintzberg (1987) goes on to provide 9 other perspectives on strategy, some discussed elsewhere in this paper. This paper, however, takes intentionally the perspective of 'almost anyone you care to ask,' to cite Mintzberg.

[3] My focus on 'choices and decisions' rather than 'actions' follows Simon's (1947) argument that any action is the outcome of an (implicit or explicit) choice among multiple potential actions, which makes 'choices' a more general concept. Like Simon (1947), I will also not distinguish between choices and decisions.

this definition of strategy back to its etymological origin as the decisions that need to be under the authority of the leader or the overall commander.

I then turn to the properties of such a strategy.[4] Strategy, as defined in this paper, generates *endogenously* a hierarchy of decisions, with more 'strategic' decisions guiding subordinate decisions. This obviously raises the question which decisions will in equilibrium be 'strategic', in the sense of being part of the strategy and guiding other decisions. The first result is that more important decisions (on a standalone basis) are more 'strategic', but only if they interact sufficiently with other decisions. The result that important decisions are strategic confirms a general intuition (which is a good thing for the definition). The simultaneous need for interaction refines this and indicates that the mechanism is different from what one might think. Important decisions are more strategic *not* just because they affect performance more but because they will be decided on their own terms so that other decisions will need to adjust to them and will thus be guided by them – hence the role of 'sufficient interaction' with other decisions. An airline's decision to hedge gas prices or currency risks is an example of an important decision – with tremendous impact on the bottom line – that is generally not considered strategic, as it typically does not guide other decisions – such as choice of target customer – but is itself guided by specific cash flow needs. A result similar to that of the importance of the decision also holds for the degree of eventual confidence in the optimal choice: decisions about which the participants are eventually confident are more strategic because they are more likely to be taken on their own terms and thus to guide other decisions. This leads to the result in Van den Steen (2012) that marketing people – who are more confident about marketing decisions – are more likely to propose a marketing-centric strategy and will appear to favor the marketing side of the business, *not* because their biased perception makes them perceive everything as a marketing problem, but because their stronger confidence in marketing decisions makes it logical to guide the organization via marketing decisions. A third and remarkable result – in view of the literature – is that irreversibility per se does *not* make the decision strategic in this static setting: being irreversible does not, by itself, make a decision a good 'guide' for other decisions.[5] I finally also show that more central decisions – in a network sense – are more strategic because they affect, and guide, more other decisions through their interactions. Customer scope, for example, has implications for almost any other choice or decision and is thus very strategic.

An indirect but important insight from this part of the analysis is that understanding the structure of strategy may enable a strategist to find the optimal strategy without a comprehensive optimization, by focusing on the strategic decisions. Strategy is thus also a decision tool. A second important process-related result is that – in this paper's setting – it often suffices to announce the strategy as cheap talk, i.e., there is not necessarily a need to centralize control of strategic decisions. A complete analysis of strategy implementation, however, is beyond the scope of this paper.

I then continue the analysis by looking at the *value* of formulating a strategy, which also gives insight in the role of strategy. I first show that interaction is necessary for strategy to have value and that irreversibility increases its value, with interaction and irreversibility being complements. But the value of strategy *de*creases in the standalone importance of subordinate decisions. These two results show the fundamental effect of a strategy: create alignment across decisions (both over time and in the cross section), but at the cost of compromising some decisions on a standalone basis. In fact, even a strategy 'bet' – when the strategist chooses a direction despite not knowing

[4]Even though the model considers both formulation/investigation and communication costs, most results are driven by formulation/investigation costs.

[5]I will discuss, however, how 'stability' – which includes irreversibility as its most important driver – may make a decision more strategic in a dynamic setting. I also argue in Van den Steen (2012) that implementation problems may create a need for commitment, which can then make irreversible decisions strategic.

the optimal decisions – can create value by generating a focal point, which improves alignment, though on a potentially suboptimal course of action. This result fits the observation that high-tech firms, which face high uncertainty, often think of strategy as 'bets'. I further show that the value of a strategy increases when there is more initial or public uncertainty, with uncertainty being a complement to the degree of interaction. The complementarity implies that uncertainty matters here *not* because uncertainty makes it difficult to find the right decision, but because uncertainty makes it difficult to predict what others will do and thus to align with their actions. A final result on the value of strategy is that a strategy creates more value when the interactions are all complements than when they are (irreducibly) a mixture of complements and substitutes. The reason is that in a (supermodular) environment with all complements, it is very important to get *all* decisions right, whereas with a mix of substitutes and complements there is always some compromise even in the optimal outcome. This result, which is about the *pattern* of interactions, suggests some caution on how to interpret the informal finding that successful strategies tend to be very well aligned: such a high degree of alignment is often due not only to skill (developing a great strategy) but also to luck (being in a supermodular environment that doesn't force a trade-off in alignment).

The paper has some implications for organization theory (beyond strategy). The results imply, for example, that good organization design is particularly valuable in settings with a supermodular payoff structure and in settings that combine uncertainty with interaction. And as strategy is also the smallest set of decisions that need to be decided centrally to get full consistency, the drivers that make a decision strategic also matter for organization design.

In a companion paper, Van den Steen (2012), I build on this paper to explore the role of people and leaders in strategy formulation: why different people may consider different decisions strategic (and may seem to favor their own department), why important decision makers should be involved in strategy development, and why leaders with strong vision are more likely to propose a strategy and their strategies are more likely to be implemented.

This paper is by necessity limited in scope: it focuses on static settings with a transparent information structure and disregards agency and dynamic issues, including how learning and change affect optimal strategy. This initial focus is just a starting point and the left-out issues suggest important directions for future research. The models themselves are for transparency reasons also very simple, often even consisting of just two decisions. The logic here is that most robust results on strategy should also hold in a two-decision setting, which is therefore a great context for formal analysis. Moreover, the mechanisms and intuition – which are very transparent in simple settings – carry over to more complex settings. But this suggests interesting questions for further research. Moreover, the paper's current setup – focused on explicitly formulated strategy in a *static* context – cannot study realized strategy (Bower 1970) or emergent strategy (Mintzberg and Waters 1985). Section 6 discusses how they relate, including how the theory can potentially contribute to these perspectives, and how the ideas relate to an individual person's strategy for solving a problem.

Literature The general management literature on strategy, such as Andrews (1987), Porter (1980), and others, often provides a definition of strategy, but as a stepping stone towards specific recommendations for good or bad strategies. Given their purpose, these definitions are not in a form that is conducive to a formal analysis. Section 3 returns to some of these definitions to show how this paper formalizes key elements. Moreover, some of this paper's results, such as the importance of interactions, confirm – or are related to – ideas suggested in the management literature (Andrews 1971, Porter 1996). I will return to this as specific results are derived.

The more academic management literature on strategy has mainly focused on the process by which strategy takes shape in organizations, with particular attention to the non-planned and non-analytical aspects. Bower (1970) and Burgelman (1994) studied how resource allocation decisions may, often inadvertently, shape strategy. Mintzberg and Waters (1985) stressed the importance of emergent strategy. The 'upper echelons theory' of Hambrick and Mason (1984) showed how top management teams' background and beliefs shaped strategy. And the 'rugged landscape' literature (Levinthal 1997, Rivkin and Siggelkow 2003) considered, among other things, how organizational structure and processes affect the search for an optimal position. The current paper complements this literature by taking the opposite path. Instead of researching how the actual processes deviate from 'strategy as deliberate planning and execution', it takes that idea and fleshes it out, making the definition more tractable and exploring its implications. This yields different, complementary, insights for strategy. Finally, while very different in approach and focus, the discussions of strategy in Ghemawat (1991) and Casadesus-Masanell and Ricart (2010) raised many of the questions that I study in this paper. The insights of Ghemawat (1991) on irreversibility and commitment were especially influential and will be discussed at different points in the analysis.

The economics literature closest to the current work is the literature that looks at the organizational effects of specific strategy choices.[6] Rotemberg and Saloner (1994, 1995), for example, (implicitly) equate strategy with a choice of scope or focus – a choice *not* to undertake a particular project or a choice to favor one department over another – and show that such a narrow scope or focus can improve the incentives for effort and can reduce the negative effects of conflict. Mailath, Nocke, and Postlewaite (2004) (implicitly) equate business strategy with a firm's choice of business and show that the existence of strategy-specific human capital may, for example, make mergers unattractive. Milgrom and Roberts (1992) have a very insightful, though informal, discussion of how coordination through strategy and coordination through prices differ, and their discussion of the Hurwicz criterion (Hurwicz 1973) is related to some of the ideas in this paper. But this literature does not provide an explicit formal definition of strategy – that would distinguish, for example, among a simple project choice, a strategy, or a full plan – or study its fundamental nature and role.

From a more structural perspective, the analysis in this paper is closely related to team theory (Marschak and Radner 1972), which studies the effect of information and decision structures when a group of people pursue a common goal but have different local information, as at time 0 of the model in this paper. This paper is part of the team theory literature where organizational performance depends on the specific *content* of decisions and on decision interactions, and where players need to make inferences about state variables in order to make good decisions.[7] From that perspective, this paper introduces strategy as an alternative solution to team theory problems.

Given its focus, the setting in this paper differs structurally from existing team theory models such as Geanakoplos and Milgrom (1991), Van Zandt (2003), or Dessein and Santos (2006) (henceforth DS), which investigate the effect of organization structure by studying how differences in information, decision, and communication structures – chosen prior to the game – affect the game's outcome.[8] In the current paper, on the contrary, no organization structure of interest is chosen prior to the start of the game. Instead, the strategist chooses *as part of the game* what decisions to investigate, to communicate, and to fix. The information, decision, and communication structures are thus part of the equilibrium. Moreover, these equilibrium outcomes may – and will – depend

[6]Starting with Brandenburger and Stuart (1996), there is also a small but growing literature on 'competitive advantage,' which is a central concept for strategy (Lippman and Rumelt 2003, MacDonald and Ryall 2004), but it is not focused on the nature or role of strategy itself.

[7]As opposed to team theory models such as Bolton and Dewatripont (1994) or Garicano (2000) where performance is measured by the *number* of problems solved and solving problems simply requires spending resources or time.

[8]As a more recent contribution, Dessein, Galeotti, and Santos (2012) looks at organizational focus.

on the realized state and on the signals (and even on the strategist's identity as in Van den Steen (2012)). These differences reflect a deeper difference in focus: existing team theory has implicitly focused on recurring decisions for which organization structure and structural measures (such as the communication hierarchies in Garicano (2000) and Van Zandt (2003) and the task allocation and communication investments in DS) are the appropriate response, whereas the current paper focuses on a *one-off* decision point or very infrequent decisions, for which a more ad hoc one-off solution (such as strategy) is optimal.[9] This difference in focus is also reflected in different modes of communication (*publicly* announcing decisions), the implicit objective (minimizing the number of decision to investigate and announce), the possibility of reverting decisions, and the discrete nature of decisions (which captures the often stark choices in one-off decision points).[10]

But these differences also limit where this paper's results appropriately apply. For example, the result that a strategy (as defined here) equals the smallest set of decisions that needs to be decided centrally applies only to this setting of one-off or infrequent decisions: for more repeated decisions, the organization can develop or adapt optimal communication and decision structures, which were excluded in this model. Nevetheless, the current paper's results on the 'value of strategy' do apply more broadly to team theory models with decentralized decisions. The reason is that the value analysis compares the optimal outcome, independent of the method by which it is achieved, with the piecemeal outcome. As a consequence, the results of Section 4 on irreversibility, on the complementarity among interactions, uncertainty, and irreversibility, and on the role of supermodularity are new insights that apply broadly to the 'value of organization' in team theory settings with decentralized decisions. The existing literature has either not investigated this, as in Crémer (1993), Prat (2002), or Dessein and Santos (2006), as the question is not salient in their context, or stayed on a much more general level without such specific comparative statics, as in the case of Marschak and Radner (1972).

Some economics papers that relate to specific sections or aspects of this paper, such as Crémer (1993), Prat (2002), and Siggelkow (2002), will be discussed later in the paper.

The main contribution of this paper is to formally define 'a strategy' – in a way that permits formal analysis and that clearly distinguishes between a strategy and either a full plan or just a set of important decisions – and to study the value and role of a strategy and the nature of strategic decisions. Besides formally confirming some existing informal insights, the paper refines these insights, provides new intuition, and derives completely new results on strategy. It also provides new insights on the value of organization more broadly.

The next section describes the model, whereas Section 3 formally defines 'strategy', relates that definition to the literature and shows that it is the equilibrium outcome of the model. Sections 4 and 5 study respectively the value of a strategy and what decisions are strategic. Section 6 discusses the links to business strategy, to realized/emergent, and to individual strategy, the interpretation as centralized decisions, and the driving forces, whereas Section 7 concludes. The proofs are in Appendix A unless otherwise noted.

[9]Whereas the role of the strategist can be interpreted as a form of hierarchy, it is a very rudimentary and minimalistic hierarchy compared to Garicano (2000) and Van Zandt (2003), as it consists of at most 2 layers, has often only an advisory role, and still chooses its own information, decision, and communication structure. But this perspective shows again how closely strategy – as defined in this paper – is tied to the role of the leader or commander.

[10]Despite superficial similarities, the payoff structure also differs fundamentally from DS. In particular, DS eliminates by construction the mutual dependency that is critical to many of this paper's results by assuming that whenever two decisions interact, at most one of them needs to adjust to an external state. While doing so is useful in their context, it eliminates most results in this paper: it mechanically equates the set of primary decisions with strategic decisions, thus eliminating Sections 3 and 5, and eliminates structural consistency conflicts, thus eliminating the results on subordinate decisions, strategy bets, and supermodularity. Only Proposition 2a remains meaningful.

2 Model

This paper studies a setting in which a group of people are engaged in a common project and must make (sequential or simultaneous) choices or decisions that affect the project's outcome. The basic research question is the nature, value, and properties of 'a strategy' (in the everyday sense of the word). To simplify the discussion, I will henceforth use 'decision' for 'choice or decision'.

Formally, consider a project that generates revenue R, which depends on a set of K decisions with typical element D_k. Each decision D_k is a choice between two alternative courses of action, $D_k \in \{A, B\}$. The project revenue R will depend *both* on whether the decisions are correct on a standalone basis *and* on whether the decisions align correctly. In terms of being correct on a standalone basis, one and only one of the choices (A versus B) will be correct, as captured by the decision state variable $T_k \in \{A, B\}$: decision D_k is correct if and only if $D_k = T_k$ and it is wrong otherwise. In terms of interactions, two decisions D_k and D_l can be either complements, in which case they should be the same (AA or BB), or substitutes, in which cases they should be opposites (AB or BA).[11] This will be captured by an interaction state variable $T_{k,l} \in \{C, S\}$ for complements (C) or substitutes (S). The revenue R is then an increasing function of the decisions being correct and of the decisions interacting correctly. In particular, I will assume that the project revenue has the following parametric form:

$$R = \sum_{k=1}^{K} \alpha_k I_k + \sum_{k=1}^{K} \sum_{l=1}^{k-1} \gamma_{k,l} J_{k,l}$$

where $\alpha_k > 0, \gamma_{k,l} \geq 0$, $I_k = I_{D_k = T_k}$ is the indicator function that decision D_k is correct, and $J_{k,l} = +1$ or -1 depending on whether the decisions D_k and D_l are aligned correctly or not. In other words, if $T_{k,l} = C$ then $J_{k,l} = +1$ if the decisions are AA or BB and $J_{k,l} = -1$ if the decisions are AB or BA, and the other way around for when $T_{k,l} = S$.[12] For much of the paper, I will work with a two-decision model ($K = 2$) and will simplify the revenue function to $R = \alpha_1 I_1 + \alpha_2 I_2 + \gamma J$ where $\gamma = \gamma_{1,2}$ and $J = J_{1,2}$. With 2 discrete decisions, this parametric form is without any loss of generality up to a constant. The interaction states in this payoff structure capture what is often called 'internal alignment' while the decision states capture 'external alignment' (e.g. Bower, Bartlett, Uyterhoeven, and Walton (1995)).

For each decision D_k there is a project participant P_k who will make that decision, with each participant making one and only one decision. Apart from these K project participants, there will also be a strategist S whose role is discussed below.

All players, including S, know the parameters α_k and $\gamma_{k,l}$, but have initially – at the start of the game – no knowledge of the states T_k or $T_{k,l}$. In particular, each player starts with a prior belief about each T_k that A and B are equally likely and with a prior belief about each $T_{k,l}$ that C and S are equally likely, with all T_k and $T_{k,l}$ being independent random variables. (Section 4 will study the effect of public/initial information by introducing an up-front public signal about one of the decision states.) The empirical probability distribution of the states and interactions is also that A and B are equally likely and that C and S are equally likely. The players thus happen to have a *common* prior belief that moreover happens to be the true empirical distribution. Van den Steen

[11] With an ordering on the actions, say that $A > B$, this indeed corresponds to the formal definition of complements and substitutes in the sense of Milgrom and Roberts (1990) and Topkis (1998) for the revenue function defined later.

[12] This choice of $J_{k,l} \in \{-1, 1\}$, as opposed to $I_{k,l} \in \{0, 1\}$, is made to ensure that the effects of complements or substitutes do not depend on the naming of the states.

1	2	3
Strategy formulation	Strategy implementation	Potential Reversion
a The strategist decides which states T_k and $T_{k,l}$ to investigate. b When she investigates a state T_k or $T_{k,l}$, the strategist receives a signal θ_k or $\theta_{k,l}$ that is correct with probability respectively p_k and $p_{k,l}$. She can then either return to 1a or continue to 1c. c The strategist can announce a set of choices and decisions D_k.	a Each participant P_k receives the signals θ_k and $\theta_{k,l}$ about (only) her decision state T_k and about (only) the interaction states $T_{k,l}$ of her decision with each of the other decisions. These signals are correct with respective probabilities p_k and $p_{k,l}$. b The strategist can publicly fix a subset of the decisions announced in 1c. c Each participant makes his or her decision (sequentially without observing others' decisions or simultaneously), if not yet fixed by the strategist.	a All signals and decisions are revealed to all participants. b Each participant P_k can decide (in ascending order) whether to reverse his decision D_k at cost c_k to the project.

Figure 1: Timing

(2012) – which studies how it matters *who* the strategist is – allows for differing priors, which makes sense for settings where strategy matters.

Whereas all players start with uninformative priors, each project participant P_k will get – in the course of the game per the timing below – *local* information about his decision. In particular, each participant P_k gets a signal $\theta_k \in \{A, B\}$ for his own decision state T_k that is correct with commonly known probability p_k. Each participant P_k also gets a signal $\theta_{k,l} \in \{C, S\}$ for each of the $K-1$ interactions $T_{k,l}$ between his own decision and any other decisions ($l \neq k$) (for a total of $K-1$ interaction signals), with each signal being correct with respective probability $p_{k,l}$. But P_k does not get any (direct) signal about any other decision state T_l ($l \neq k$) or about interactions between other decisions $T_{l,m}$ ($l, m \neq k$). (If he makes no relevant inference from the strategist's announcements, then P_k thus keeps his prior beliefs about T_l and $T_{l,m}$.) Let $\theta = (\theta_k; \theta_{k,l})_{k,l \in K, l<k}$ denote the vector of all potential signals.

If the strategist S – in the course of the game per the timing below – decides to investigate a decision state T_k (resp. an interaction state $T_{k,l}$), she gets the same signal $\theta_k \in \{A, B\}$ (resp. $\theta_{k,l} \in \{C, S\}$) – correct with probability p_k (resp. $p_{k,l}$) – as the local participant P_k. Letting the content and the informativeness of the strategist's signals be identical to those of the decision makers, as if they see the same information, seems like the simplest and most neutral assumption. But allowing these signals to differ is an interesting direction for further research.

The timing of the game is indicated in figure 1. At the start of the game, the strategist decides which decision or interaction states to (privately) investigate. If the strategist investigates some decision state T_k (resp. some interaction state $T_{k,l}$), she thus gets the signal θ_k (resp. $\theta_{k,l}$) about the true state. After receiving the signal, she can decide whether to investigate another state, and so on, or to continue. To keep the analysis transparent, I will assume that there is no cost to investigating a state, but everyone has a lexicographic preference for less investigations: when otherwise indifferent, everyone prefers less states to be investigated. This is equivalent to assuming an infinitesimal cost of investigating a state.[13] Based on the signals from all investigations, the strategist can then announce one or more decisions. (The equilibrium set of announced decisions will turn out to be exactly an optimal strategy, as formally defined later). I will again assume that there is no cost from announcing decisions but that everyone has a lexicographic preference for announcing less: when otherwise indifferent, everyone prefers less decisions to be announced. This is again equivalent to assuming an infinitesimal cost of announcing a decision. With respect to investigating *versus* announcing, I

[13]The effect of such costs (and of different costs for different decisions) are important topics for further research.

will assume that players have a lexicographic preference for announcing over investigating: when otherwise indifferent, players prefer to first minimize the number of state investigations and to then minimize the number of decisions announced. This captures the considerable cost involved in collecting comprehensive information for state investigations.

In stage 2a of the game, each participant P_k gets his or her local information (θ_k and $\theta_{k,l}$'s). In stage 2b, the strategist can potentially force the implementation of the strategic decisions by publicly fixing any of the decisions that she announced in 1c, but only these decisions. (It will turn out that – in this setting – the strategist will never fix decisions in equilibrium, with the exception of the strategy bet in Proposition 3. But allowing this possibility helps the analysis and interpretation.) There is no cost to fixing a decision but everyone has a lexicographic preference for fixing less decisions: when otherwise indifferent, everyone prefers less decisions to be fixed by the strategist, which is again equivalent to an infinitesimal cost of fixing an announced decision. The reason for this assumption – that the strategist can fix some of the decisions – is to separate for now the strategy implementation issue, i.e., the issue that employees may simply disregard the CEO's strategy. The analysis here throws some light on this issue – as the strategist's equilibrium interventions to fix decisions are an indicator of implementation problems – and Van den Steen (2012) analyzes this issue further to study the role of leadership in strategy. But a full analysis is beyond the scope of either paper.

In stage 2c, all participants then make their decisions either simultaneously or sequentially (in random order) without observing each others' decisions, to capture the setting of a large organization.[14] (Almost all of the analysis would also go through for a model with sequential decisions that are publicly observed. But this does not seem a very realistic assumption for large organizations.)

In stage 3, all signals and decisions are revealed. Each participant P_k (sequentially in ascending order) can reverse her decision D_k at cost c_k. This possibility of reversion is introduced to study the effect of decisions being more or less reversible. When that is not the focus of the analysis, I will assume that all $c_k = \infty$, so that decisions are completely irreversible (as in most economic models).

Let $\tilde{c}$ denote the sum of all reversion costs c_k that are actually incurred. The players' objective is to maximize the expected value of $\Pi = R - \tilde{c}$. This is equivalent to assuming that all players' utility is a strictly increasing function of Π and that players are risk neutral. I thus assume here that all players, including S, are cooperating on the same project and share the same objective. Extending the model by introducing competitors or independent players – who have different objectives and whose decisions may affect the focal organization – or by introducing more agency conflict is an important direction for further research but beyond the scope of this paper.

I will focus in the analysis on pure strategy equilibria that are symmetric in signals in the sense that switching A and B in all signals also switches A and B in all announcements in 1c and in all action choices in stage 2. The rationale for imposing such symmetry is that any *a*symmetric equilibrium requires sophisticated and precise coordination on the particular equilibrium that is being played, which is unrealistic in the context of an organization that struggles with the much simpler task of coordinating its decisions.[15] For similar reasons, I also focus on equilibria that are 'robust to implementation', in the sense that the outcome remains unchanged if the decisions announced

[14] Simultaneous decisions are mathematically equivalent to sequential decisions where people are not aware of others' decisions when they make their own decision.

[15] An example of such an excluded equilibrium is an equilibrium where, whenever the optimum is for all players to choose A, the strategist announces no decisions at all. Given common knowledge of the equilibrium, all participants know that they should choose A– and will thus coordinate on the right outcome – whenever no strategy is announced. Such equilibrium is not very realistic for any setting where strategy matters since it requires a high degree of coordination on the meaning of 'no strategy'. The symmetry condition excludes such equilibria.

as part of the strategy were all fixed in period 2b. (This only plays a role in Proposition 7.) The unobservability (or simultaneity) in stage 2c also introduces the possibility of multiple equilibria. The equilibrium selection criterium that I will apply is that of symmetric belief-based learning or fictitious play (Fudenberg and Levine 1998) for the subgame starting in 2c, which seems most appropriate to capture the setting of a large organization where people have difficulty coordinating. In such symmetric belief-based learning, each player starts with the naive starting belief that all other players will randomly and independently choose between A and B, with both actions equally likely. Each player chooses her own action as a best response to these (naive) beliefs. Each player then observes all others' actions and updates her beliefs accordingly. And so on. If there are multiple equilibria, I will select the equilibrium to which this learning process converges.

I will finally use some recurring notation throughout the paper. Let $\beta_k = \alpha_k(p_k - .5)$ and $\eta_{k,l} = \gamma_{k,l}(2p_{k,l} - 1)$ combine, for respectively the decision and the interaction states, the importance with the eventual confidence. Let Z_k denote the piecemeal choice for D_k, i.e., the choice that maximizes I_k. Define the 'piecemeal outcome' or 'trivial outcome' as the outcome where each player chooses Z_k. For any variable denoting a decision choice, say $X \in \{A, B\}$, let $\overline{X}$ denote the complement, i.e., $\overline{X} \in \{A, B\} \setminus X$.

3 Strategy: Definition and Equilibrium Outcome

With this model as background, I now return in more detail to the definition of strategy as the 'smallest set of choices and decisions sufficient to guide all other choices and decisions'. The objective of this section is threefold: 1) relate this paper's definition to the literature, 2) further formalize the definition in the context of the game of Section 2, and 3) show that such a strategy is indeed the equilibrium outcome of that game. (The main body of the paper – outside the proofs – does not need the level of detail and formalism that is developed in the latter 2 parts. The informal definition of strategy and the statement of Proposition 1 generally suffice.)

To relate this definition to the literature, a few observations are helpful. First, and most importantly, the 'choices and decisions' that make up the strategy can range from being narrow and concrete choices to, more often, being broad and high-level choices, depending on what generates the smallest set to give full guidance. Very narrow choices such as 'a price of $249' require a lot of choices to give full guidance, whereas very broad choices such as 'be the preferred solution provider' or 'maximize shareholder value' fail to give any real guidance, so that neither of these extremes is likely to be optimal. High-level choices – such as a choice to 'grow to 17,000 financial advisors by 2012' versus 'stay the same size' – often function as objectives for lower levels of the organization (Simon 1947), which is important to relate this definition to the literature. A second important observation is that the players in this model can be interpreted as parts of the firm, such as 'production' or 'marketing'. The CEO's strategy then specifies the minimum set of decisions to guide all functions. (Each function, such as marketing or production, may further translate the overall strategy to a functional strategy.) A third and final observation is that this definition implicitly assumes an overall target outcome towards which the strategy guides and an organizational context within which the strategy operates. For example, with respect to the latter, the ability of the strategist to collect information and the assignment of employees to decisions are part of the organizational context in this model. Some organizational choices will thus precede strategy, some will be strategic, and some will be guided by the strategy.

The paper's introduction explained how the definition captures the idea – explicit and implicit in the literature – of 'strategy as a plan'. The fact that the strategy is expressed in terms of a 'set of (intended or actual) choices and decisions' – including choices of objectives – is consistent with much of the management literature. Andrews (1987), for example, defines strategy as a 'pattern of *decisions* [...]'; Porter (1996) describes it as '*choosing* [...] activities;' McKinsey defined it as a 'handful of *decisions*' (Coyne and Subramaniam 1996). Chandler's (1969) early definition as the 'determination of [...] goals and objectives [...], the adoption of courses of action [..., and] the allocation of resources' is also essentially about choices and decisions.[16] The idea that the choices and decisions (that make up the strategy) 'guide' (towards an objective) is obviously implicit in the idea of 'strategy as plan' and is also explicit in Collis and Rukstad (2008) or in McKinsey's definition of strategy as 'a handful of decisions that drive or shape most of a company's subsequent actions [...]' (Coyne and Subramaniam 1996).

It is instructive to relate this paper's definition to the list-based definitions of strategy by Saloner, Shepard, and Podolny (2001) or Collis and Rukstad (2008). The latter, for example, describe strategy – based on their experience – as specifying a choice of objective, a choice of scope, and a choice of advantage. This list of choices or decisions can be interpreted as an average experience-based 'smallest set of choices sufficient to guide all other choices' for the most common situations. The theory in this paper is thus very complementary to, and consistent with, these list-based definitions by providing a rationale for such a list, by providing an evaluation criterium to potentially further refine the list, and by providing a logic for adjusting the list to specific settings, circumstances, or evolutions. For example, whereas these list-based definitions do not specify in how much detail, say, the firm's scope should be specified, this paper's definition suggests a concrete criterium. In the other direction, Saloner, Shepard, and Podolny (2001) and Collis and Rukstad (2008) give a very concrete expression to this paper's definition.

Overall, the paper's definition captures existing ideas about strategy in a form that enables a formal analysis (and that provides a useful complementary perspective on strategy). I now turn to the formalization of the definition in the context of the model of Section 2. As mentioned earlier, what follows is more abstract and more detail-oriented than what is needed for the rest of the paper.

For purposes of the formal definition, note first that a strategy as the 'smallest set of choices sufficient to guide all other choices' is only meaningfully defined relative to a target outcome, and relative to the audience and the available information. The need to specify the target outcome is obvious, as guidance only makes sense when there is a clear target outcome. The need to specify the audience and available information comes from the fact that 'smallest sufficient' depends on what the relevant players know. For example, if it is common knowledge among the participants that $Z_2 = A$ then there is often no need to specify $D_2 = A$ in the strategy. But for an audience that does not know that $Z_2 = A$, the strategy must compensate for that more limited shared knowledge. More generally, I conjecture that optimal strategies for insider audiences will be more sparse than for outsider audiences, especially when the organization has shared beliefs (Van den Steen 2010).

With these considerations in mind, the definition of strategy as the 'smallest set of choices and decisions to guide all other choices and decisions' can then be reformulated in the context of the model of Section 2: a strategy – given the target outcome and what the participants know and observe – is the smallest set of decisions D_k to announce (and fix) so that the equilibrium of the

[16] Simon (1947) refers explicitly to game theory when defining strategy as 'a series of such *decisions* which determine behavior'. Drucker (1973) defines strategic planning in part as 'the continuous process of making (...) *decisions* (...).' Barney (2011), despite defining strategy formally as a 'theory', informally describes it as a '*actions* [that] firms take' (p10). Note that Barney's (2011) 'choice of theory' can be interpreted in the context of Section 2 as the strategist announcing her beliefs about state variables, thus explaining the *logic* of the strategy. Doing so makes sense in many contexts, though giving *only* the logic – without the actual choices and decisions – might not be sufficient to get alignment. This is an interesting normative question that deserves more attention.

subgame starting in stage 2c implements the target outcome. In order to also define strategy for non-optimal outcomes, I need to assume (for the definition) that all decisions in the strategy are also implemented, i.e., that all decisions announced in 1c are automatically fixed in 2b.[17]

To completely formalize this definition, I need to introduce some notations and terminology. Let the target outcome, which may depend on the vector of signals θ, be denoted $\tilde{\mathbf{D}}(\theta) = (\tilde{D}_1(\theta), \ldots, \tilde{D}_K(\theta))$. One target outcome of particular importance is the optimal outcome, denoted as $\hat{\mathbf{D}}(\theta)$: for each θ, $\hat{\mathbf{D}}(\theta)$ maximizes R. Let a 'pattern of investigation' be a complete contingent plan for the strategist with regard to which states to investigate in stage 1. (A 'pattern of investigation' is thus a game-theoretic-strategy for the strategist for stages 1a and 1b.) Let an 'investigation outcome' $\tilde{\tau}$ be the set of realized signals that the strategist has observed by the start of stage 1c. Let $\tau'_{\tilde{\tau}} \subset \theta$ be the subvector of signals that the strategist has not investigated by the start of stage 1c and $\tilde{\tau}'_{\tilde{\tau}}$ a particular realization of $\tau'_{\tilde{\tau}}$. Note that – because the strategist's choice of signals to investigate may depend on the realization of earlier investigated signals – $\tau'_{\tilde{\tau}}$ will often depend on that particular realization of signals $\tilde{\tau}$ and not just on the investigation pattern. Denote the set of all possible realizations of $\tau'_{\tilde{\tau}}$, i.e., the set of all $\tilde{\tau}'_{\tilde{\tau}}$, as $\mathcal{T}'_{\tilde{\tau}}$ (which may thus also depend on the particular realization of signals $\tilde{\tau}$). Let, finally, $K_{\mathcal{S}} \subset K$ denote the indices of the subset of decisions that are part of the strategy $\mathcal{S}$.

Definition 1 *A* strategy $\mathcal{S}$ *(for a target outcome $\tilde{\mathbf{D}}(\theta)$, a commonly known pattern of investigation, and an investigation outcome $\tilde{\tau}$ that is consistent with the pattern of investigation) is a set of decision choices $(D_k = \tilde{d}_k)_{k \in K_{\mathcal{S}}}$ for a subset of decisions $K_{\mathcal{S}} \subset K$ such that*

1. *$\tilde{d}_k = \tilde{D}_k(\tilde{\tau}, \tilde{\tau}'_{\tilde{\tau}})$ for all $k \in K_{\mathcal{S}}$ and for all $\tilde{\tau}'_{\tilde{\tau}} \in \mathcal{T}'_{\tilde{\tau}}$,*
2. *for any $\tilde{\tau}'_{\tilde{\tau}} \in \mathcal{T}'_{\tilde{\tau}}$, the outcome $\tilde{\mathbf{D}}(\tilde{\tau}, \tilde{\tau}'_{\tilde{\tau}})$ is an equilibrium outcome of the subgame starting in stage 2c – with no reversions in stage 3 – when $\tau'_{\tilde{\tau}} = \tilde{\tau}'_{\tilde{\tau}}$, when $(D_k = \tilde{d}_k)_{k \in K_{\mathcal{S}}}$ were announced in stage 1c and fixed in stage 2b, and when the players update their beliefs given the pattern of investigation and the announcement in 1c,*
3. *there does not exist a set of decision choices $\check{d}_k$ for a subset of decisions $K_{\check{\mathcal{S}}} \subset K$ such that the two previous conditions are satisfied and $\#K_{\check{\mathcal{S}}} < \#K_{\mathcal{S}}$.*

An optimal strategy formulation *is a pattern of investigation and a set of strategies, one for each possible investigation outcome, that implement the optimal outcome at the smallest expected number of investigations.*

An optimal strategy *for $\tilde{\tau}$ is a strategy for $\tilde{\tau}$ that is part of an optimal strategy formulation.*

A strategy does not necessarily exist for every pattern of investigation and $\tilde{\mathbf{D}}$, however. For example, if the pattern of investigation is empty and the desired outcome $\tilde{\mathbf{D}}$ is neither the trivial outcome nor a constant, then no strategy exists. But when the pattern of investigation investigates all signals, then a strategy exists for any $\tilde{\tau}$ (that then includes a realization for each signal) and $\tilde{\mathbf{D}}$: one candidate strategy that satisfies the first two conditions of the definition is $D_k = \tilde{d}_k = \tilde{D}_k(\tilde{\tau}), \forall k$, so that condition 3 then minimizes over a finite non-empty set and a strategy always exists. This further ensures that the overall problem of finding an optimal strategy is well behaved (as there is only a finite number of possible investigation patterns).[18]

[17] This is necessary because the strategist may not fix decisions in 2b when the intended outcome is not optimal in her eyes. By automatically fixing all announced decisions, it is as if the strategist *wants* to implement the strategy.

[18] The role of backwards induction here reminds of the hypothesis/options driven approach that is often advocated for the development of business strategy (Rivkin 2002).

This definition allows the strategy announcement to influence the beliefs, i.e., it allows the players to make inferences about the strategist's observations based on the announced strategy. In some instances, such inferences are realistic. It is, for example, not unusual to hear someone defend their company's strategy against an alternative by saying "I'm sure our management knew about that option and thus concluded that it's no good." But sometimes such inferences are unrealistic. Whereas more research is needed to understand this better, such inferences can be (partially) excluded by embedding the game in a larger one that introduces some potential confusion about the exact equilibrium investigations. All results seem to go through under an appropriate refinement.

The following proposition then captures the key result that the strategist will in equilibrium announce exactly an optimal strategy.

Proposition 1 *In any equilibrium, the set of decisions announced by the strategist in stage 1c is exactly an optimal strategy.*

Proof : As neither the investigation of states nor the announcement or fixing of decisions have a monetary cost (because they affect only lexicographic preferences), the equilibrium of the game must generate the maximum payoff (given the signals θ), i.e., the outcome must be the optimal outcome $\hat{\mathbf{D}}$. It further follows that, in equilibrium, the strategist will announce in stage 1c and fix in stage 2b a respective set of decisions such that the equilibrium of the subgame starting in stage 2c implements the optimal outcome for any realization of signals. Moreover, among all sets of decisions that so implement the optimal outcome, the strategist will choose the one with the smallest number of decisions to announce (given her lexicographic preference for announcing less decisions). Furthermore, among all investigation patterns, the strategist will choose the one that minimizes the expected number of investigations. That set of decisions is thus an optimal strategy. This proves the proposition. ■

While this result follows directly from the setup, it is important because it connects the definition of strategy as the 'smallest set of choices to guide all other choices' with the important practice of 'looking ahead to the overall problem when making one particular decision'. This provides a clear rationale for the use of strategy in practice and a reference point to think about the concept.

4 The Value of Strategy

When thinking about strategy, at least three questions immediately come up: Why does strategy matter? What does it look like? And how do you find one? The following sections will study (on a relatively general level) each of these questions.

I start with the value of strategy because it also gives insight into what strategy 'does', i.e., *how* it affects the ultimate outcome, which helps for understanding the nature and development of an optimal strategy.

Apart from confirming some general intuitions about strategy – which is important for a formal theory to show that the definition 'makes sense' – the first results of this analysis also give useful insight into its role. For this formal analysis, I will study the model of section 2 with two decisions ($K = 2$) and with all $c_k = c$ for some exogenously given c. (Allowing different c_k does not seem to generate extra results that are particularly interesting.) The analysis measures the value of developing a strategy by comparing the game with and without the investigation and announcement of stage 1. Proposition 2a then shows that the value of developing a strategy is higher when there are stronger interactions among the decisions, when eventual confidence about these interactions is higher, and when decisions are more difficult to reverse. Moreover, interactions and irreversibility are complements: the degree to which irreversibility makes strategy more valuable is higher when there are strong interactions, and the other way around.

Proposition 2a *The value of developing a strategy increases in the degree of decision interaction (γ), in the eventual confidence in the interaction ($p_{1,2}$), and in the degree to which decisions are difficult to reverse (c). Decision interaction, eventual confidence in the interactions, and irreversibility are all complements with respect to the value of strategy.*

The role of interaction can be formulated more sharply.

Corollary 1 *Interactions ($\gamma > 0$) are a* necessary *condition for strategy to be of value.*

Proof : This follows directly from setting $\gamma = 0$ in the proof of Proposition 2a. ■

The intuition is that absent interactions there is no gain from aligning decisions and thus no gain from an overall 'strategy' to guide decisions. A business that is all about getting a few decisions correct, with no interactions, gains little from strategy. This ties back to the idea that the key role of strategy is to generate consistency across decisions, both over time and across functions, and confirms the central role of interactions in strategy as suggested by the management literature (Andrews 1971, Porter 1996). A similar intuition holds for the strategist's confidence about the nature of the interactions: if the strategist doesn't know whether the interaction requires complements or substitutes, then there is no value from aligning and thus no value from strategy.

The intuition for irreversibility is that when all decisions are reversible, interactions can potentially be resolved through ex-post adjustment and there is less value from an up-front strategy (Ghemawat 1991).[19] The complementarity implies that even a completely irreversible decision does not require strategy if it does not interact with other decisions.

Proposition 2a also provides a new perspective on the idea of 'strategy as a pattern (of decisions)'. In particular, even though a strategy so defined is not necessarily a pattern – because it may consist of a single choice – its key role is always to *generate* a pattern. Strategy only matters when there should be a pattern in the decisions and strategy makes sure that that pattern is realized.

A more technical observation that is useful for the rest of the analysis is that the importance of an interaction and the eventual confidence in that interaction have essentially the same effect in Proposition 2a. This will be a recurring result caused by the fact that both factors work through the same channel: they both affect the importance of getting that particular decision or interaction right. If the participants aren't very confident about the right decision or interaction, then it is also less important to make sure that the decision or interaction follows whatever they think is right.

Before continuing, it is useful to introduce some terminology and notation. The proof of Proposition 2a shows that one decision – the one with the higher $\alpha_k(p_k - .5)$ – will be taken on its own terms while the other decision will adjust to it (or be guided by it). I will refer to the first as the 'dominant' decision and to the latter as the 'subordinate' decision and I will use $\overline{k} = \operatorname{argmax}_k \alpha_k(2p_k - 1)$ and $\underline{k} = \operatorname{argmin}_k \alpha_k(2p_k - 1)$ as the respective indices.

An obvious question at this point is how the value of strategy depends on the importance of individual (standalone) decisions. Whereas it is obvious, and straightforward to show, that the value of strategy increases when there is a *proportional* increase in the importance of *all* interactions ($\gamma_{k,l}$) *and* of *all* individual decisions (α_k), the value of strategy does *not* increase with the importance of one individual decision (α_k) by itself. In fact, the opposite is true: as Proposition 2b below shows, the value of strategy *decreases* in both the importance ($\alpha_{\underline{k}}$) and the eventual confidence ($p_{\underline{k}}$)

[19]Irreversibility, however, is not a necessary condition for strategy to be of value: even unlimited ex-post adjustments may not lead to the optimal decision in the face of local optima and sticking point (Rivkin and Siggelkow 2002).

of the subordinate decision. The reason is that the only way for strategy to achieve coordination is by compromising on individual (subordinate) decisions. When standalone decisions increase in importance, the compromises and trade-offs get tougher. This reduces the value that strategy can create. The same is true for the eventual confidence in the decision. The following proposition captures that result formally.

Proposition 2b *The value of developing a strategy* decreases *in the importance ($\alpha_{\underline{k}}$) of the subordinate decision and the eventual confidence ($p_{\underline{k}}$) in it.*

Proof : This follows directly from equation 1 in the proof of Proposition 2a. ■

To see this result in action, consider the following example from Ryanair (Rivkin 2000). All Ryanair's routes are short distance flights. For a fixed turnaround time at the gate, short distance flights spend a larger share of their time on the ground, relative to long distance flights. Turnaround time thus becomes an important cost driver. One way to speed up the turnaround time is to eliminate food service. That, on its turn, is feasible for Ryanair, precisely because customers care little about food service on short distance flights. In other words, compromising on food service is inconsequential for an airline with only short distance flights, which makes it feasible to align its decisions around a fast turnaround time and create a lot of value doing so. If, instead, customers cared highly about food service, then alignment would be more costly and strategy would create less value.

These two propositions reflect the fact that strategy deals with the trade-off between the often conflicting objectives of external and internal alignment (e.g. Bower, Bartlett, Uyterhoeven, and Walton (1995)). 'External alignment' means ensuring that the organization's decisions fit the organization's environment, and is captured here by the standalone effect of the decisions α_k and p_k. 'Internal alignment' means ensuring that the organization's decisions fit each other, and is captured here by the interactions $\gamma_{k,l}$ and $p_{k,l}$. In this paper, an organization without a strategy has relatively good external alignment, since each decision maker fully considers the local environment, but it does badly on internal alignment. Strategy improves internal alignment at the cost of external alignment: subordinate decision will sometimes be piecemeal *sub*optimal to improve alignment. What is not considered in the current setup, is that internal and external alignment may also sometimes interact. In that case, strategy may improve both internal and external alignment, although there will typically still be a trade-off at the margin. This is an interesting issue for further research.

Before continuing with comparative statics on the value of strategy, it is useful to explore somewhat further the role of strategy by considering whether and how a strategy *bet* can add value and how that compares to the optimal strategy. I therefore turn to that issue now, and then return to some more comparative statics on the value of strategy.

The value of a strategy *bet* It is sometimes said that it is more important to just choose *some* direction than to delay (or to invest more) in order to find the *optimal* direction. A related observation is that managers of high-tech start-ups often talk in terms of 'bets' rather than strategy, reflecting a sense that they are forced to make important and far-reaching choices without having much information to base these choices on. Does it make sense to make such 'bets'? Both of these observations raise the question what the gain from *some* strategy is even when it may be uninformed and thus potentially suboptimal.

To analyze this formally, I will consider a modified version of the model of Section 2 where the strategist cannot investigate any states at all but can still announce (and implement) a strategy, i.e., can announce/fix decisions in stages 1c and 2b. What is the value from such strategy 'bet' and what would such strategy look like? For this analysis, I continue to assume that $K = 2$ and that all decisions carry the same cost of reversal, i.e., $c_k = c$ for all k. The following proposition then shows that strategy can add value without information about the optimal decisions and even without knowing whether decisions are substitutes or complements.

Proposition 3 *There is value from a strategy* bet *when γ, $p_{1,2}$, and c are large relative to α_k and p_k, in particular when $\gamma(2p_{1,2} - 1) > \alpha_{\overline{k}}(p_{\overline{k}} - .5) + \alpha_{\underline{k}}(p_{\underline{k}} - .5)$ and $c > \alpha_{\overline{k}}(2p_{\overline{k}} - 1)$. The value increases in γ, $p_{1,2}$, and c, and decreases in α_k and p_k. The γ, $p_{1,2}$, and c are again all complements with respect to the value of a strategy* bet*.*

When a strategy bet *adds value,* any *one-decision strategy (i.e., either $\mathcal{S} = (D_1 = A)$, or $\mathcal{S} = (D_1 = B)$, or $\mathcal{S} = (D_2 = A)$, or $\mathcal{S} = (D_2 = B)$) is optimal (within the set of strategy bets).*

A first obvious question is how strategy can add value without the strategist even knowing whether the decisions are complements or substitutes. The reason why strategy 'works' here is because people *want* to align their decisions with others when γ is large, but they can only do so if they know what others will do. When γ is sufficiently large relative to α_k and p_k, it becomes optimal to blindly commit one decision, in order to allow others to align with that.[20] But since the strategy is uninformed, the internal alignment comes at the cost of a considerable loss of external alignment: under the optimal strategy bet, the external alignment is no better than random. The optimal strategy bet is therefore most valuable at high γ and $p_{1,2}$ but at low α_k and p_k. The somewhat counter-intuitive result that irreversibility makes a strategy bet more valuable is driven by the fact that the inability to correct internal misalignment dominates the inability to correct a wrong bet whenever a strategy bet is optimal.

This benchmark clarifies the role of strategy from a different angle: Without *any* strategy, the organization does relatively well on external alignment, but no better than random on internal alignment. With the optimal strategy *bet*, things switch to the other extreme: the organization does well on internal alignment, but no better than random on external alignment. The optimal *informed* strategy, finally, optimally trades off internal and external alignment.

An important challenge for 'strategy as a bet' is implementation: employees may doubt that managers will follow-through on the announced strategy. In fact, the optimal strategy bet is not an equilibrium if strategy is just cheap talk because fictitious play selects the piecemeal equilibrium instead. A strategy bet thus requires a commitment device, which can be managerial reputation, a strategist-leader with strong views (Van den Steen 2012), or an irreversible decision.

I now return to the comparative statics on the value of strategy. For the remainder of this section, I will assume that $c_k = \infty, \forall k$, i.e., that all decisions are completely irreversible.

Uncertainty Informal observation and intuition also suggest that uncertainty drives the need for strategy: absent uncertainty, everyone knows the optimal decisions so that there seems to be no role for strategy.[21] What the analysis here shows is that the reason why uncertainty makes strategy valuable is *not* because uncertainty makes it hard to choose the right decision, but because uncertainty makes it hard to anticipate others and thus to align with their actions.

To investigate these effects of initial uncertainty, I will consider here a 2-decision ($K = 2$) setting where – at the start of the game – all players get a common public signal about one of the states.[22] The question is how this reduction in initial uncertainty affects the value and role of

[20]Puranam and Swamy (2011) suggest an alternative: a wrong 'map' can cancel out 'superstitious learning.'

[21]Strategy may matter under complete information as it may affect the selection among multiple equilibria. But this is driven by a different form of uncertainty: uncertainty about others' actions.

[22]The reason for considering a public rather than private signal is that the results for public signals are both more interesting and more tractable. Private signals would have similar but less effects.

strategy. Formally, let everyone observe a public signal $\sigma_2 \in \{A, B\}$ that $T_2 = \sigma_2$ with probability μ_2. The signal σ_2 is a garbling of θ_2: σ_2 equals θ_2 with probability q, and equals A and B with equal probability otherwise, so that $\mu_2 = .5 + q(p_2 - .5)$ and $.5 < \mu_2 < p_2 < 1$. Initial uncertainty about D_2 can then be measured by the variance $U_2 = \mu_2(1 - \mu_2) \in (0, .25)$.

The following proposition not only shows that the value of strategy increases with initial uncertainty but also that the increase is larger when the degree of decision interaction and the eventual confidence about the interaction are larger.

Proposition 4 *The value of developing a strategy increases in the initial (public) uncertainty U_2 about the decision state T_2. Uncertainty is (with respect to the value of strategy) a complement to the degree of interaction and to the eventual confidence in the interaction.*

The complementarity result is key to understanding the role of uncertainty: uncertainty makes strategy valuable, but only when combined with a high level of interaction, which shows that the relevant effect of initial/public uncertainty is not to make it hard to find the correct decision but to make it hard to predict what others will do and thus to coordinate with them. The role of strategy in the face of uncertainty can again be interpreted in terms of internal and external alignment: the public signal allows participants to anticipate better what others will do. This improves internal alignment (at the cost of some external alignment), but the limited information on which it is based implies that it will still underperform optimal strategy not only because it is more likely to coordinate on the wrong action (reducing external alignment) but also because players will trust it less than a more informed strategy and are thus less likely to be guided by it (reducing internal alignment).

Another useful interpretation of the role of strategy comes from observing that – in this model with a public but imperfect signal about one or more states – a player may *knowingly* coordinate on the wrong action (when her private signal contradicts the public signal). In a modified version of this game it may even happen that all players knowingly coordinate on the wrong action (when each got an independent private signal that contradicts the public signal). The role of strategy is then to create *common knowledge* of the optimal action, which then becomes a focal point for more responsive coordination. This perspective is most relevant in the context of change from a suboptimal status quo: strategy can help to create change by creating common knowledge of an alternative optimum. This enables participants to align jointly on a new course of action.

Complements, Substitutes, and Supermodularity Whereas the critical role of individual interactions was already highlighted, it turns out that also their overall pattern matters. I will show, in particular, that strategy is more valuable in a (supermodular) setting with all complements than in a (non-supermodular) setting with both complements and substitutes. The reason is that the pattern of interactions may impose constraints on whether they can all be satisfied at the same time and thus on the amount of value that can be created through strategy. This has two implications. First, in settings with all complements, it becomes especially important to have a strategy (as it is especially important to get all decisions right). Strategic companies will thus outperform myopic ones most in settings that are rich in complements. But, second, the most perfect strategy creates only mediocre alignment and performance in a setting with both substitutes and complements. The degree of alignment may thus be a misleading measure for the quality of the strategy.

This has important empirical implications. Picking companies with great performance will result in picking companies that happen to be in industries or segments with lots of potential complements. Selecting on the dependent variable may thus mislead into thinking that strategy *creates* complements in settings where it only takes advantage of existing ones. (For example, the fact that fast turnarounds are beneficial to companies with short distance flights is a physical fact and not something 'invented' by Ryanair through its strategy.) Moreover, companies that are aware of the structure of interactions are more likely to invest in developing a strategy when that structure is supermodular than when it is not, leading to inverse causality from complements to strategy. Overall, even though alignment is one of the key objectives of strategy, one has to be careful when interpreting the degree of alignment as a measure for the quality of strategy.

Before getting to the formal result, I need to discuss a technical point that is important for both the results and the analysis here: if (exactly) two decisions are complements and we rename the decision choices for one of these – i.e., we switch the A and B labels for one of the decisions – then these two decisions become substitutes (and the other way around). Technically, if x and y are complements then x and $-y$ are substitutes and the other way around. It follows that no general results for complements versus substitutes can be derived with only two decisions (and one interaction) because any result for complements is also a result for substitutes. But this only holds for two decisions and not for 3 decisions. In particular, in a setting with 3 decisions and 3 interactions, every time you try to switch an interaction from complement to substitute (or the other way around), you necessarily also switch another one. This places restrictions on the patterns that can be achieved and leads to a number of 'canonical' patterns that cannot be reduced to each other, creating a partition with equivalence classes. In the case of 3 decisions, the two canonical forms are, on the one hand, a setting with all complements and, on the other hand, a setting with 2 complements and one substitute. All other patterns can be reduced to one of these two, but these two cannot be reduced to each other. Following the literature on complementarities (Milgrom and Roberts 1990, Topkis 1998), a setting with all complements is called 'supermodular'. I will therefore denote these two cases as 'supermodular' and 'non-supermodular'. I will now study a setting with 3 decisions ($K = 3$) and 3 interactions and compare the supermodular and non-supermodular cases. I will assume, for simplicity, that all interactions have the same combined importance/confidence: for some fixed η, $\gamma_{k,l}(2p_{k,l} - 1) = \eta$ for all k, l. The following proposition then captures the result.

Proposition 5 *For given α_k, p_k, and η, both the likelihood that there is a gain from strategy and the expected gain from strategy are larger in the supermodular case than in the non-supermodular case.*

Proposition 5 may seem related to the results of Crémer (1993), Prat (2002), and Siggelkow (2002), but is in fact quite different. Crémer (1993) showed that two decision makers who face a team-theoretic setting with an unknown state variable are better off getting identical signals about that state when their decisions are complements but independent signals when their decisions are substitutes. Siggelkow(2002) showed that when two (positive) choice variables interact, misperceptions of the interaction are more costly under complements than under substitutes because errors (caused by the misperception of the interaction) are being amplified under complements versus attenuated under substitutes (for strictly positive variables). Prat (2002) generalized the most important parts of Crémer (1993) to supermodular and submodular settings, and independently derived the main result of Siggelkow (2002) for this more general setting. These results are very different than the irreducible trade-offs among the interactions of Proposition 5. More importantly, something like Proposition 5 simply *cannot* hold for a 2 decision setting as studied by Crémer (1993) or Siggelkow (2002) (because getting the alignment right is as valuable under complements as under substitutes). And since Prat (2002) generalizes these results, the difference extends. The current result is fundamentally about a pattern of multiple interactions as opposed to the type of one single interaction.

Implications for Organization Design The results in this section were derived by comparing the optimal outcome to the piecemeal outcome – without reference to what causes the difference. It follows that these results have relevance for organization design beyond strategy. In particular, one way to think about the 'value of good organization' in a context with recurring decisions is exactly like the 'value of strategy' in this context with one-off decisions: as the difference between the overall maximum payoff versus the payoff from locally optimal decisions. The results of this section thus carry over to that question (for the relevant determinants). This implies, for example, that designing a good organization is particularly important in settings with supermodular payoffs, in settings with strong interactions, and in settings that combine high uncertainty and irreversibility with lots of interaction.

5 The Nature of Strategic Decisions and the Strategy Process

Deciding what decisions are 'strategic', i.e., what decisions should be included in the strategy, is a challenge for managers, students, and scholars alike. For example, most people tend to say that Walmart's strategy is to be 'low-cost'. But the strategy of KMart was also to be 'low-cost'. And these two competitors had very different strategies, with very different results. Clearly 'low-cost' is thus not sufficient to characterize either Walmart's or Kmart's strategy. It has, in fact, proved hard to pin down what makes a decision strategic and why. But it is an important question if you need to develop a strategy: it is hard to find a strategy if you don't know what to look for. This importance is also reflected in the fact that Collis and Rukstad (2008) received one of the most coveted awards in the business press for an article on exactly this issue. In the article, they provided an experience-based list of generic decisions that make up a strategy: a choice of objective, of scope, and of competitive advantage. While being a very valuable starting point for practitioners, such lists lack a rationale or explicit criterium, which makes it difficult to adapt it to specific or changing circumstances or to determine how far each element should be detailed.

This paper's approach to strategy has the benefit that its definition implies a clear rationale and general principles for which decisions are 'strategic' and which aren't. That is the focus of this section. This analysis also leads to another important insight: it shows how understanding the structure of strategy may make the strategy development process more efficient by enabling the strategist to find the optimal strategy without doing a comprehensive optimization.

For this analysis, I first need to formalize the definition of being 'strategic'. The criterium I use here is the likelihood that the decision is part of the strategy.[23]

Definition 2 *The degree to which a decision is 'strategic' equals the probability that it is, in equilibrium, part of the optimal strategy (weighing multiple equilibria equally).*

To now derive general principles on what makes a decision 'strategic', I will focus again on the $K = 2$ setting, but I will allow the cost of reversal to differ by decision ($c_1 \neq c_2$) in order to study how a decision's reversibility affects it being strategic or not. The following proposition then shows that important decisions are strategic, though only if they also interact sufficiently. Moreover, irreversibility does *not* make a decision strategic.

Proposition 6 *A decision is more strategic when its standalone importance α_k and eventual confidence p_k increase and when the importance $\gamma_{k,l}$ and eventual confidence $p_{k,l}$ of its interactions*

[23] An alternative would be to take the likelihood of being investigated as (part of) the criterium. At least in this paper, these two alternatives give identical results.

increase, with standalone importance and confidence being complements to interaction importance and confidence. The level of irreversibility c_k does not *affect whether a decision is strategic.*

Proof : If $\gamma(2p_{1,2}-1) \leq \alpha_{\underline{k}}(p_{\underline{k}} - .5)$ then the piecemeal outcome is always optimal so that any optimal strategy is an empty set. It follows that, in that case, no decision is strategic.

When $\alpha_{\underline{k}}(p_{\underline{k}} - .5) < \gamma(2p_{1,2}-1)$, then the optimal outcome has $D_{\underline{k}} = D_{\overline{k}} = \theta_{\overline{k}} = Z_{\overline{k}}$ when $\theta_{1,2} = C$ and $D_{\overline{k}} = \theta_{\overline{k}} \neq D_{\underline{k}}$ when $\theta_{1,2} = S$. This will in equilibrium be implemented with the following (optimal) investigation and announcement: investigate $T_{\overline{k}}$ in stage 1b, announce $D_{\overline{k}} = Z_{\overline{k}}$ in stage 1c (and fix *no* decision in stage 2b). To see that the (unique) subgame equilibrium starting in 2c indeed implements the optimal outcome, note the following for the case that $\theta_{1,2} = C$ (and completely analogous for $\theta_{1,2} = S$). In any pure-strategy subgame equilibrium, the (game theoretic) strategy of $P_{\overline{k}}$ must be to 'always choose X' for some fixed $X \in \{A, B, Z_{\overline{k}}, \overline{Z}_{\overline{k}}\}$ and the (game theoretic) strategy of $P_{\underline{k}}$ must be to 'always choose Y' for some fixed $Y \in \{A, B, Z_{\overline{k}}, \overline{Z}_{\overline{k}}, Z_{\underline{k}}, \overline{Z}_{\underline{k}}\}$. Any subgame equilibrium where either player chooses 'always X' for $X \in \{A, B\}$ is not symmetric in the signals. Moreover, since $\alpha_{\underline{k}}(p_{\underline{k}} - .5) < \gamma(2p_{1,2}-1)$, the best response for $P_{\underline{k}}$ to $P_{\overline{k}}$ choosing 'always X' with $X \in \{Z_{\overline{k}}, \overline{Z}_{\overline{k}}\}$ is to also choose 'always X'. This leaves as potential equilibria '$Z_{\overline{k}}$-$Z_{\overline{k}}$' and '$\overline{Z}_{\overline{k}}$-$\overline{Z}_{\overline{k}}$' among which the equilibrium selection rule always selects '$Z_{\overline{k}}$-$Z_{\overline{k}}$', which is thus the unique (symmetric pure-strategy) subgame equilibrium.

To see that this is the only overall equilibrium, note the following:

1. Since the announcement alone implements the optimal outcome without any fixing (in 2b), there will be no fixing in equilibrium.

2. As the piecemeal outcome may differ from the optimal outcome (which is the case, for example, when $\theta_{\overline{k}} \neq \theta_{\underline{k}}$ and $\theta_{k,l} = C$), the optimal outcome can only be implemented for sure by investigating at least one state in stage 1b. The only condition under which the optimal outcome can be implemented with less than one announcement is when the piecemeal outcome is optimal (in which case an empty strategy can implement the optimal outcome). But coming to that conclusion requires 3 state investigations, so the lexicographic preference for announcement over investigation implies that everyone prefers 1 investigation and 1 announcement. It follows that any equilibrium must have exactly one investigation and one announcement.

3. To see that it is the only equilibrium, note that the only alternative that announces only one decision would be to announce $D_{\underline{k}}$ (or to alternate announcing $D_{\overline{k}}$ and $D_{\underline{k}}$). But finding the right value for $D_{\underline{k}}$ requires investigating $T_{\overline{k}}$ and $T_{1,2}$. So this can't be optimal.

This completes the proof. ■

Whereas most people would agree that important decisions are more strategic, it is not immediately clear *why* that is the case. The result here not only provides a clear intuition but also modifies the principle itself as shown in the following corollary.

Corollary 2 *An important decision is not strategic unless it interacts sufficiently: for any α_k and p_k, there exist $\gamma_{k,l}$ (or $p_{k,l}$) such that D_k is not strategic.*

Proof : When either $\gamma_{k,l} = 0$ for all l or $p_{k,l} = .5$ for all l, then no other decision will depend on the choice for D_k, so that D_k will never be part of any strategy. ■

Figure 2 provides an example: whereas decision D_3 is more important (and with more confidence) than either D_1 or D_2, it is not strategic. The strategist will not investigate it or announce it and will instead let P_3 use her local (expert) information to make that decision. Decision D_1 on the other hand, is strategic: the principal will investigate it and announce is, so that it can guide D_2. A practical example of an important decision that is most often not strategic is an airline's decision to hedge currency or fuel contracts: whereas such decisions have a tremendous impact on the bottom line, they usually do not guide other decisions – such as which customers to target –

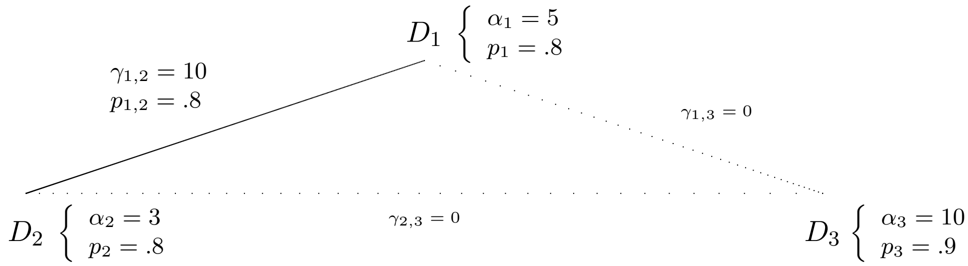

Figure 2: An example of an important decision that is not strategic

but are themselves guided by the cash flow needs implied by other decisions, and are therefore not strategic. Similarly, a technological choice buried deeply in a product design may critically affect a company's success or failure, but that does not – by itself – make that decision strategic.

The result here also gives a precise intuition: more important decisions are more strategic *not* because they have more impact on the project payoff, but because they are made on their own terms, i.e., without regard to what is optimal for other decisions. The other decisions thus have to adapt to them and be guided by them if there is sufficient interaction. To make that possible, the important decisions must be public, i.e., be part of the strategy. To see this another way: having a greater direct effect on performance does not, by itself, make a decision more guiding. The intuition for eventual confidence (or residual uncertainty) is similar.

The result that irreversibility does not make a decision strategic is surprising given that Ghemawat (1991, p42-46) singled out 'irreversibility' as a critical factor in making a decision strategic. Whereas Proposition 2a confirmed Ghemawat's (1991, p29-31) argument that irreversibility makes strategy more important – since you can't align ex post, alignment has to come through strategy – irreversibility does not make a decision strategic in this static context because it does not directly affect the decision's ability to guide other decisions. The irreversible decision may instead be guided by other decisions. Consider the following example based on Ghemawat (1987). Around 1985, Coors needed to decide on the construction of a large brewery on the East Coast, which only made sense if Coors pursued a national (versus regional) strategy. Whereas the construction decision was essentially an irreversible decision, the choice of geographic scope should be the strategic decision, guiding decisions such as the brewery construction. Letting the brewery construction – the irreversible decision – drive the choice of geography would put the cart before the horse. In conclusion, an irreversible decision makes it vital to develop a strategy but is not necessarily part of the strategy, at least not in the current setting.

Beyond the current setting, however, there seem to be two potential reasons why irreversible decisions may be more strategic, related to, respectively, dynamics and implementation. Whereas both conjectures require more research, I mention them here to clarify the potential role of irreversibility. For the dynamic setting, I conjecture that stable decisions – decisions that are unlikely to change – are more strategic for two reasons. First, if the decision is changed at a later time, such change will undo all the internal consistency that a strategy was meant to generate. Unstable decisions are thus less likely to generate internal consistency than equivalent stable decisions. Second, anticipating this exact issue, other decisions will be less inclined to let themselves be guided by an unstable decision, making unstable decisions also less effective as a guide. A decision's stability, on its turn, depends both on how likely it is that a decision maker will *want* to change it and whether she *can* change it. Stability of the first type may be caused by the fact that no new information is forthcoming or that new information is unlikely to challenge the original decision. Stability of the second type is the same as irreversibility and the argument here is very closely related to the dynamics-based argument in Ghemawat (1991), and thus seems to confirm that argument. Despite this role of irreversibility in making a decision strategic, it remains an important caveat that the fact that irreversible decisions *end up* (by nature) guiding other decisions does not automatically imply that they *should* guide other decisions. Often, the irreversible decisions should optimally be guided themselves by truly strategic decisions so that their (automatic) guidance simply materialize the guidance from the strategic decisions. This issue is a very important direction for further research. Van den Steen (2012) conjectures a second reason why irreversibility may make a decision strategic: irreversibility can provide a much-needed commitment in the face of implementation issues caused by potential disagreement between the strategist and those who need to implement the strategy. And it may then make sense to build a strategy around an irreversible decision.

Strategy Process Proposition 6 is also important from a very different perspective: it shows that the optimal strategy does not necessarily require a full investigation of all states. In particular, the following corollary shows that for $K = 2$ it suffices to investigate and announce the dominant decision. The strategist does not even investigate the type of interaction (substitute or complement) between the decisions.

Corollary 3 *When $K = 2$, it suffices to investigate the state of the dominant decision $T_{\overline{k}}$ in order to determine the optimal strategy. The optimal strategy is either $\mathcal{S} = (D_{\overline{k}} = T_{\overline{k}})$ or the empty set.*

Proof : This follows directly from the proof of Proposition 6 ■

An understanding of the structure of strategy may thus enable a strategist to be more efficient at finding it. Strategy is thus also a decision-making tool.

Network Centrality Returning now to the question of what makes decisions strategic, an obvious dimension to consider is centrality: if the role of strategic decisions is to guide other decisions, then one would expect more central decisions – which affect more decisions – to be more strategic. I will measure centrality here by the weighted sum of adjacent links divided by the weighted sum of all links, with a link's weight being its combined importance and eventual confidence $\eta_{k,l}$.

To study this formally, I consider a setting with 3 decisions ($K = 3$) and 2 interactions, so that one decision is by construction more central than the other two. To focus on the effect of the interactions, I will assume furthermore that all decisions have the same importance: for some given β, $\alpha_k(p_k - .5) = \beta$ for all k. The following proposition confirms that network-central decisions are more strategic because they guide many decisions at once.

Proposition 7 *The more central decision is (weakly and for a non-empty parameter range strictly) more strategic.*

A good example of this is the choice of scope, i.e., which customers to serve with which products. This simple decision has an impact on nearly any aspect of the business, from pricing and advertising to production and R&D. A small change in the choice of scope can reverberate through the whole business system. Scope decisions are therefore very strategic in nature. To see this more sharply, look at this example from the opposite angle: imagine a setting where – unlike most typical settings – a business could change its customer scope without changing anything else: it could make identical products with the identically same R&D and marketing as before and through the exact same sales channel as before, but simply sell now to a different target group. Such change in customer choice without *any* repercussions for other functions would be much less strategic. Note also that like supermodularity, centrality is about the interaction pattern rather than individual interactions.

Strategy Implementation Whereas the model was not set up to investigate strategy implementation, the analysis gives some perspective on what does (not) drive implementation problems. In particular, the following proposition shows – for the settings of this section – that the participants will implement the strategy without the strategist fixing any decisions.

Proposition 8 *The strategist does not (need to) fix any decisions in stage 2b of the equilibria in Propositions 6 or 7.*

Proof : This follows immediately from the proofs of these propositions. ■

This has two important implications. First, strategy as a pure cheap-talk announcement *can* be effective. Second, implementation issues must be driven by factors beyond this simple conflict-free setting. But the intuition is more complex than 'aligned objectives make everyone want to follow the strategy'. For example, the strategy bet of Section 4 requires the strategist to intervene. Whereas this issue requires more research, it bears resemblance to the stag-hunt game where implementation becomes a problem with more players. Van den Steen (2012) also shows that the leader's involvement in strategy development may be important in the face of implementation issues.

6 Discussion

'Business' Strategy Even though the paper purposely looks beyond business, its first motivation was to better understand business strategy. Applying this theory to business raises a number of interesting questions. A first question is how to think about competitors' actions and interactions in the model. Introducing competitors would mean that some of the players have different, or even opposite, objectives. It also means that decisions controlled by a competitor can't be fixed in 2b. Moreover, strategy will now also try to influence, or guide, competitors' behavior. Developing the theory in this direction is an important area for future research.

A business context also puts more structure on the setting, which may lead to context-specific insights that may not be transferable to, say, non-profits. For example, with regard to the claimed importance of being 'different' or of having a 'unique' competitive advantage, the analysis shows that there is nothing in strategy itself that suggests a need to be different. In fact, being 'different' makes no sense without someone or something to be different from and thus implies by necessity some form of competition. The need to be different in business traces back to the logic of the Hotelling line (d'Aspremont, Gabszewicz, and Thisse 1979), and its relevance depends on the relevance of the Hotelling logic. Whether it is important for a university to be different from others depends on the degree to which it is in direct competition (for students, faculty, or funds) with others and whether the proposed differentiation matches the type of competition.

Emergent and Individual Strategy Whereas this paper is explicitly focused on intentional, explicitly formulated strategy, the static nature of the model is just a (temporary) simplification rather than an essential feature. The end-goal is a dynamic theory, where the initial strategy explicitly plans for experimentation to further refine and develop the strategy. To the degree that 'emergent strategy' refers to such dynamically evolving plan (Mintzberg and Waters 1985), a dynamic version of the theory may be relevant.

Despite its focus on intentional strategy, however, this theory can also be useful for the analysis of non-intentional 'realized' strategy (Bower 1970), i.e., a realized pattern of action that may potentially conflict with the original plan. In particular, it can be helpful to make the concept of 'pattern of decisions' more concrete. Similar to Simon's (1947) view that every action shows a 'revealed preference', any pattern of actions corresponds to an 'as if' plan, to a 'revealed plan' that leads to this pattern (whether or not it really was the plan). Boiled down to its most essential choices this becomes a 'revealed strategy'. Such 'revealed strategy' is a maximally concise and well-defined description of a potentially complex pattern of actions. It thus provides a very concrete and consistent operationalization of the idea of a 'pattern of actions', which has been somewhat missing in the literature. Second, the revealed strategy is a prime candidate 'explicitly formulated strategy' for any company that wants to implement that pattern of actions. Finally, informal observation also suggests that such 'revealed strategy' is often exactly what people refer to when asked to describe the current strategy of a company: they infer which strategy the company might have followed to get to this pattern of action.[24] Such statement does not imply that they necessarily attributed intention to the company, only that the actions are consistent with such a plan.

This paper can also be useful to understand what it means for an individual to have a strategy (such as a 'job search strategy' or 'exam taking strategy'). Consider a person faced with a complex task that requires many decisions over time, with each decision interacting with other decisions. To avoid analyzing the full problem time and again when new decisions come up, strategy as 'the smallest set of decisions sufficient to guide all other decisions' is the most memory- and calculation-efficient solution to this problem and thus provides a role for 'individual strategy'.

The 'Centralized Decisions' Interpretation One can potentially interpret this paper as being about 'which decisions to decide centrally'. To see this, note that all results of the paper remain unchanged when step 2b – where the strategist can publicly fix decisions – is merged with step 1c – where the strategist announces decisions. The model can then be further simplified by eliminating the announcement altogether and just letting the strategist publicly fix decisions in stage 1c. At that point, these decisions simply become the decisions that the strategist decides to centralize.

While this connects the ideas in this paper to the etymological origins of strategy as the decisions that should be under control of the CEO, one has to be very careful with this interpretation for more practical purposes. In particular, Proposition 8 showed that it was often not necessary to centralize the decisions as long as the strategist could announce the strategy. So the results are not about which decisions *should* be centralized. Moreover, this paper's focus on one-off decisions (typical for strategy) explicitly excluded more structural means to set direction, such as designing information or communication structures to deal with interactions. For more frequent decisions, it might be optimal to design some organizational process to let the relevant lower-level managers sort it out. Just like the earlier team-theory models were not a good fit to study strategy, this model is not a good fit to study recurring decisions that require structural solutions.

But the interpretation does suggest interesting conjectures for organization design. It suggests that decisions with 'strategic' characteristics would optimally be taken at a higher organizational level. The organizational hierarchy of (recurring) decisions may thus look similar to the hierarchy of decisions induced by strategy for a one-off setting.

Driving Forces With both a cost of investigation – which includes the cost of inference and thus of strategy formulation – and a cost of communication in the model, it is a logical question which of these is the driving force. It turns out that most results are driven by the cost of investigation/formulation. For example, even without communication costs, the optimal strategy is

[24] According to Mintzberg (1987), the fact that people can describe a company's current or past strategy shows that strategy is not necessarily a plan. The argument here suggests that such description can, and probably often should, be interpreted as a plan, in particular a revealed plan.

an equilibrium outcome and the unique one for the two-decision setting. Eliminating the costs of investigation/formulation, on the other hand, has a more profound impact: the optimal strategy is not necessarily an equilibrium outcome any more, not even in the 2 decision setting.

7 Conclusion

This paper suggested a very simple but concrete formalization of the definition of strategy as '*the smallest set of choices or decisions sufficient to guide all other choices and decisions*' and used it to study the value, role, and nature of strategy.

Some of the paper's results confirm general intuition about strategy, for example that interaction and uncertainty make strategy more valuable and that important decisions are strategic. Such intuition-confirming results are important for a formal theory because they show that the definition 'makes sense'. But these results also did more, either by refining the insight or by providing a clear rationale for it. I showed, for example, that important decisions are strategic only if they interact with other decisions. Whether to hedge fuel prices, for example, is a decision that it usually not strategic even though it can have a tremendous impact on financial performance.

The paper also derives completely new results. It shows, for example, that the value of strategy depends on the *pattern* of interactions – strategy is less valuable with a mixture of complements and substitutes than with all complements – and that irreversibility per se does not make a decision strategic in this static setting. The paper further showed that strategy is not only a tool to guide and coordinate an organization, but also a decision making tool: understanding the structure of strategy allows the strategist to find the optimal outcome more efficiently.

An important insight of the paper is to show how the many things that we intuitively associate with strategy fit exactly together: strategy as committing to one path, strategy as being decided by the CEO or general manager, strategy as coordination device, strategy as looking ahead, strategy as broad direction, etc. Such conceptual understanding of how these ideas hang together is helpful for thinking about and developing good strategies.

Finally, the paper also has some implications for organization theory more broadly. It implies, for example, that good organization is particularly valuable in supermodular settings and it generates some conjectures on the allocation of decisions in a hierarchy.

This paper's setup was extremely simple to keep the analysis transparent. But that simplicity immediately suggests avenues for further research. For example, the model's static nature begs the question how the strategicness of particular decisions and the value of strategy would be affected if states may change over time or if information trickles in. Other obvious directions for research are the role of competition, the effect of different action, information, or payoff structures, or micro-foundations for the investigation and communication costs. Overall, I hope that this paper furthers the formal study of strategy.

A Proofs of Propositions

Proof of Proposition 2a: Remember that Z_k denotes the choice for D_k that maximizes I_k and that $\eta_{k,l} = \gamma_{k,l}(2p_{k,l}-1)$, $\eta = \eta_{1,2}$, and $\gamma = \gamma_{1,2}$. I will also define $\overline{k} = \text{argmax}_k\, \alpha_k(2p_k-1)$ and $\underline{k} = \text{argmin}_k\, \alpha_k(2p_k-1)$. Since there is no cost (beyond lexicographic preferences) for investigating/announcing/fixing decisions, the strategist can always implement the maximum expected payoff when all signals θ are revealed (since she can in principle investigate *all* states and fix *all* decisions). The value of strategy thus equals the difference between, on the one hand, the maximum expected payoff when all signals θ are revealed (and one person can choose all decisions) and, on the other hand, the expected equilibrium payoff if stage 1 did not exist.

Consider now first the optimal choices, denoted $\hat{D}_k$, when all signals are known. By renaming the decision choices, I can assume here wlog. that $\theta_{1,2} = C$. If now $Z_1 = Z_2$, then $\hat{D}_1 = \hat{D}_2 = Z_1 = Z_2$, and the payoff is $\alpha_1 p_1 + \alpha_2 p_2 + \eta$. If $Z_1 \neq Z_2$, then there are 3 candidates for the optimal outcome:

1. $D_1 = Z_1$ and $D_2 = Z_2$ with payoff $\alpha_1 p_1 + \alpha_2 p_2 - \eta$.
2. $D_1 = Z_1$ and $D_2 = \overline{Z}_2$ with payoff $\alpha_1 p_1 + \alpha_2(1-p_2) + \eta$.
3. $D_1 = \overline{Z}_1$ and $D_2 = Z_2$ with payoff $\alpha_1(1-p_1) + \alpha_2 p_2 + \eta$.

If $\overline{k} = 1$ and $\underline{k} = 2$ then $\alpha_1 p_1 + \alpha_2(1-p_2) + \eta \geq \alpha_1(1-p_1) + \alpha_2 p_2 + \eta$ and only candidates 1 and 2 are left, and analogously for $\overline{k} = 2$ and $\underline{k} = 1$. It follows that the optimal solution is to always set $D_{\overline{k}} = Z_{\overline{k}}$ and to set $D_{\underline{k}} = Z_{\overline{k}}$ if $\eta \geq \alpha_{\underline{k}}(p_{\underline{k}} - 1/2)$ and $D_{\underline{k}} = Z_{\underline{k}}$ if $\eta \leq \alpha_{\underline{k}}(p_{\underline{k}} - 1/2)$. The expected payoff is $\alpha_{\overline{k}} p_{\overline{k}} + \frac{\alpha_{\underline{k}}}{2} + \eta$ if $\eta \geq \alpha_{\underline{k}}(p_{\underline{k}} - 1/2)$ and $\alpha_{\overline{k}} p_{\overline{k}} + \alpha_{\underline{k}} p_{\underline{k}}$ if $\eta \leq \alpha_{\underline{k}}(p_{\underline{k}} - 1/2)$.

Consider next the equilibrium outcome in the case without stage 1 (and thus without any fixing in 2b) and without reversing any decisions ex-post. By renaming the decisions – and since $\theta_{1,2}$ will be common knowledge among the two decision makers by stage 2c – I can condition on $\theta_{1,2} = C$ being common knowledge by stage 2c. Moreover, by stage 2c, participant P_k knows his signal θ_k whereas his belief about T_{-k} is still his prior that T_{-k} is equally likely to be A and B. It follows that in any pure strategy equilibrium, the (game theoretic) strategy of any participant P_l must be 'always choose X' for some fixed $X \in \{A, B, Z_l, \overline{Z}_l\}$. Consider first the case that P_{-k} chooses 'always Z_{-k}' (or, analogously, chooses 'always $\overline{Z}_{-k}$'). In that case, P_k (lacking any signal about T_{-k}) believes that D_{-k} equals A as B with equal probability. That reduces his choice problem to $\max_{D_k} E[\alpha_k I_{D_k=T_k}]$, which is maximized by $D_k = Z_k$. It follows that each participant P_k choosing Z_k is an equilibrium for any value of the parameters, and that there is no equilibrium where a player P_k chooses $\overline{Z}_k$. Consider next the case that P_{-k} chooses always A (resp. always B), then P_k's choice problem becomes $\max_{D_k} E[\alpha_k I_{D_k=T_k} + \gamma J_{D_k=A}]$ (resp. $\max_{D_k} E[\alpha_k I_{D_k=T_k} + \gamma J_{D_k=B}]$), which is maximized by either 'always $D_k = Z_k$' or by 'always $D_k = A$' (resp. 'always $D_k = B$'). It follows that the only possible equilibria are $A - A$, $B - B$, and $Z_1 - Z_2$. However, $A - A$ (and, analogously, $B - B$) does not satisfy the symmetry condition: when all signals are switched, both players still choose A instead of switching to B. It follows that the unique symmetric equilibrium for this case is that $D_k = Z_k, \forall k$. Since the choices will be aligned half the time, the expected payoff from this equilibrium equals $\alpha_1 p_1 + \alpha_2 p_2 = \alpha_{\overline{k}} p_{\overline{k}} + \alpha_{\underline{k}} p_{\underline{k}}$.

Consider finally the equilibrium outcome in the case without announcing/fixing in stage 1c/2b but *with* reversing, again conditional on $\theta_{1,2} = C$ being common knowledge by stage 2c. Consider the gain to a player from changing his decision from the original piecemeal solution. If $Z_1 = Z_2$, there is obviously no gain from reversing any decision, so assume that $Z_1 \neq Z_2$. In that case – since the cost of reversing is the same for all decisions and each player tries to maximize overall profits Π – the decision with the lowest $\alpha_k(2p_k - 1) + c$ will reverse as long as that $\alpha_k(2p_k - 1) + c$ is smaller than 2η.

Taking the last two cases together, the expected payoff from the equilibrium without strategy equals $\alpha_{\overline{k}} p_{\overline{k}} + \alpha_{\underline{k}} p_{\underline{k}}$ if $\eta \leq \alpha_{\underline{k}}(p_{\underline{k}} - .5) + c/2$ and $\alpha_{\overline{k}} p_{\overline{k}} + \frac{\alpha_{\underline{k}}}{2} + \eta - c/2$ if $\eta \geq \alpha_{\underline{k}}(p_{\underline{k}} - .5) + c/2$.

I can now calculate the gain from formulating a strategy. When $\eta \leq \alpha_{\underline{k}}(p_{\underline{k}} - \frac{1}{2})$, the gain from strategy is zero (since the payoff always equals the piecemeal payoff $\alpha_{\overline{k}} p_{\overline{k}} + \alpha_{\underline{k}} p_{\underline{k}}$).

When $\eta > \alpha_{\underline{k}}(p_{\underline{k}} - \frac{1}{2})$, the gain from strategy equals

$$\min\left(\eta - \alpha_{\underline{k}}(p_{\underline{k}} - \frac{1}{2}), c/2\right) = \min\left(\gamma(2p_{1,2} - 1) - \alpha_{\underline{k}}(p_{\underline{k}} - \frac{1}{2}), c/2\right) \tag{1}$$

The comparative statics on γ, $p_{1,2}$, and c and the fact that γ and $p_{1,2}$ are complements with respect to the value of strategy follow. The complementarity between γ and c and between $p_{1,2}$ and c follows from $\min_i(f_i(z_i)))$ being supermodular when all f_i are increasing (Topkis 1998). This proves the proposition. ■

Proof of Proposition 3: As before, there is no gain from any strategy possible when $\eta \leq \beta_{\underline{k}}$. So assume henceforth that $\eta > \beta_{\underline{k}}$. Absent any decision state signal, the optimal non-trivial outcome is to align the two decisions (assuming it can be implemented) which gives expected payoff $\frac{1}{2}(\alpha_1 + \alpha_2) + \eta = \eta + \frac{\alpha_{\overline{k}}}{2} + \frac{\alpha_{\underline{k}}}{2}$. Remember from Proposition 2a that the expected payoff from *not* having a strategy equals $\max(\alpha_{\overline{k}} p_{\overline{k}} + \alpha_{\underline{k}} p_{\underline{k}}, \alpha_{\overline{k}} p_{\overline{k}} + \frac{1}{2}\alpha_{\underline{k}} + \eta - c/2)$. It follows that the gain from having the optimal uninformed strategy, equals $\min\left(\eta - \alpha_{\underline{k}}(p_{\underline{k}} - \frac{1}{2}) - \alpha_{\overline{k}}(p_{\overline{k}} - \frac{1}{2}), c/2 - \alpha_{\overline{k}}(p_{\overline{k}} - \frac{1}{2})\right)$. Moreover, when this value is strictly positive, then each player is willing to compromise his decision to ensure that the interaction is correct. It follows that this obtains by choosing as strategy $\mathcal{S} \in \{(D_1 = A), (D_1 = B), (D_2 = A), (D_2 = B)\}$. Moreover, all these strategies have the same expected payoff, so that *any* of the one-decision strategies is optimal. ■

Proof of Proposition 4: Since the decision choices can always be renamed (and since $\theta_{1,2}$ will be common knowledge by 2c), I can assume $\theta_{1,2} = C$ and $\sigma_2 = A$. Since a strategy can only be optimal when $\beta_{\underline{k}} < \eta$, I henceforth also assume that $\eta > \beta_{\underline{k}}$.

To determine how the 'value of strategy' depends on the initial uncertainty, note that the expected payoff from the optimal strategy equals $\alpha_{\overline{k}} p_{\overline{k}} + \alpha_{\underline{k}}.5 + \eta$ (i.e., the expected payoff when all signals are known) and is thus independent of the amount of initial uncertainty. So it suffices to show that – for any given set of parameters except μ_2 (and thus for a given optimal strategy payoff) – the expected payoff absent a strategy (and thus absent investigations) decreases as there is more uncertainty, i.e. as U_2 increases or as μ_2 or q decrease, and that this change is larger when η is larger.

Consider thus the case without any (project) strategy, i.e., without any investigation/announcement/fixing in stages 1b/1c/2b, and consider P_k's best response in stage 2c. If P_k believes that P_{-k} chooses A and B with equal probability, then P_k's best response is to choose Z_k. Else, let X_{-k} denote P_{-k}'s most likely action according to P_k (based on P_{-k}'s assumed equilibrium behavior and the potential prior signal σ_{-k} about T_{-k}) and let $\psi_{-k} > .5$ denote P_k's belief that $D_{-k} = X_{-k}$. With her choice for D_k, P_k can only affect the direct payoff from D_k and the interaction payoff. Conditional on $\theta_{1,2} = C$, P_k solves $\max_{D_k} \alpha_k [p_k I_{D_k=Z_k} + (1-p_k)(1 - I_{D_k=Z_k})] + \gamma\left[(2\psi_{-k}-1)I_{D_k=X_{-k}} - (2\psi_{-k}-1)(1 - I_{D_k=X_{-k}})\right]$ or $\max_{D_k} \alpha_k [(2p_k - 1)I_{D_k=Z_k} + 1 - p_k] + \gamma\left[(2\psi_{-k}-1)(2I_{D_k=X_{-k}} - 1)\right]$. Since both $2p_k - 1 > 0$ and $2\psi_{-k} - 1 \geq 0$, the payoff increases in both $I_{D_k=Z_k}$ and $I_{D_k=X_{-k}}$. It follows that P_k's best response is either $D_k = Z_k$ or $D_k = X_{-k}$.

Since X_{-k} is derived from common knowledge events (including P_{-k}'s assumed equilibrium behavior), X_{-k} must be common knowledge. It follows that, conditional on $\theta_{1,2} = C$, if P_k's strategy is to choose X_{-k}, then $X_k = X_{-k}$ and P_{-k}'s best response is either to also choose $X_k = X_{-k}$ or to choose Z_{-k}. Furthermore, if P_k's strategy is to choose Z_k, then $X_k = A$ for $k = 2$ (by the assumption that $\sigma_2 = A$), whereas X_k is undefined for $k = 1$ (since there is no prior signal for T_1). This leaves the following as potential equilibria: 'each P_k always chooses Z_k', 'P_2 chooses Z_2 and P_1 chooses A', or 'both always choose X' with $X \in \{A, B\}$.

Consider now first the two potential equilibria of the form 'both choose X' with $X \in \{A, B\}$. This is an equilibrium iff for each player P_k– knowing that P_{-k} will choose X for sure – it is optimal to choose X even when $Z_k \neq X$. This condition (for P_k) can be written: $\alpha_k(1 - p_k) + \eta \geq \alpha_k p_k - \eta$ which thus results in the overall equilibrium condition $\eta \geq \max_k \alpha_k(p_k - .5)$. This condition is the same for 'both always choose A' and 'both always choose B'.[25] The expected payoffs of these equilibria are respectively $\alpha_1/2 + \alpha_2\mu_2 + \eta$ and $\alpha_1/2 + \alpha_2(1 - \mu_2) + \eta$.

Consider next the potential equilibrium where 'each chooses Z_k'. Note that this means, from an outsider's perspective, that $P[D_1 = A] = P[D_1 = B] = .5$ while $P[D_2 = A] = P[\theta_2 = A] = q + (1-q).5 = (1+q)/2$. The best response for P_2 to 'P_1 chooses Z_1' is indeed to always choose Z_2. The best response for P_1 to 'P_2 chooses Z_2' is to choose A if $\alpha_1(1-p_1) + \eta(1+q)/2 + (-\eta)(1-q)/2 \geq \alpha_1 p_1 + (-\eta)(1+q)/2 + \eta(1-q)/2$ or $q\eta \geq \alpha_1(p_1 - .5)$, and to choose Z_1 if the inequality holds in the other direction (with both being best response under equality). The equilibrium condition for 'each chooses Z_k' is thus that $q\eta \leq \alpha_1(p_1 - .5)$. The

[25]It will turn out that 'both always B' is never selected by the equilibrium selection criterium, but that can be invoked only later. For now, 'both always B' has to be included among the set of equilibria.

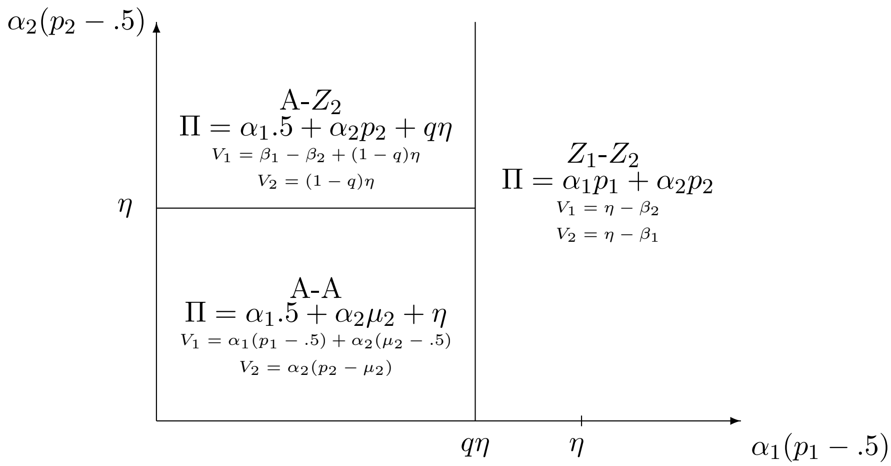

Figure 3: Equilibrium Regimes and Payoffs in Function of Parameters.
(V_k is the value of strategy when D_k is the dominant decision.)

expected payoff of this equilibrium equals $\alpha_1 p_1 + \alpha_2 p_2$.

Consider finally the potential equilibrium where 'P_1 chooses A and P_2 chooses Z_2'. The above analysis implies that 'P_1 chooses A' is a best response to 'P_2 chooses Z_2' if $\eta \geq \alpha_1(p_1 - .5)/q$. The best response to '$P_1$ chooses A' is 'P_2 chooses Z_2' if $\alpha_2 p_2 - \eta \geq \alpha_2(1 - p_2) + \eta$ or $\eta \leq \alpha_2(p_2 - .5)$. So the condition for this equilibrium is that $\alpha_2(p_2 - .5) \geq \eta \geq \alpha_1(p_1 - .5)/q$. The expected payoff of this equilibrium equals $\alpha_1/2 + \alpha_2 p_2 + \eta(1+q)/2 + (-\eta)(1-q)/2 = \alpha_1/2 + \alpha_2 p_2 + q\eta$.

I derive now the equilibria for the different parameter ranges, as depicted in Figure 3. First, whenever $\alpha_1(p_1 - .5) \geq q\eta$, 'each chooses Z_k' is an equilibrium and it is the equilibrium that will be selected by the equilibrium selection criterium (since the starting point of the equilibrium selection process coincides with this equilibrium outcome). Second, when $\alpha_1(p_1 - .5) < q\eta$ (and thus $\eta > \alpha_1(p_1 - .5)$), the equilibrium is '$P_1$ chooses A and P_2 chooses Z_2' when $\eta \leq \alpha_2(p_2 - .5)$ and 'both always choose A' otherwise.

To prove the proposition, I will now show that – for any given set of parameters excluding μ_2 (and thus for a given optimal strategy payoff) – the expected payoff absent a strategy decreases as there is more uncertainty, i.e. as U_2 increases or as μ_2 and/or q decrease, and that these changes are larger when η is larger. To that purpose, it suffices to show that 1) the result hold for each of the equilibrium payoffs and 2) the results also hold upon an equilibrium regime transition.

The fact that each of the (selected) equilibrium payoffs by itself decreases as q decreases and that these changes are larger when η is larger is straightforward.[26] It thus suffices to show the same results upon a transition in equilibrium regime.

In terms of equilibria regime transitions, the effect of a decrease in q is to go from either 'both always choose A' or from 'P_1 chooses A and P_2 chooses Z_2' to 'each chooses Z_k'. So I need to show that these equilibrium regime transitions (weakly) decrease the payoffs and that these changes are larger when η is larger. The change in payoff going from 'P_1 chooses A and P_2 chooses Z_2' to 'each chooses Z_k' equals $\alpha_1(p_1 - .5) - q\eta \equiv 0$ at the equilibrium regime transition (as follows from the equilibrium regime criteria). The change in expected payoff going from 'both always choose A' to 'each chooses Z_k' equals $\alpha_1(p_1 - .5) + \alpha_2(p_2 - \mu_2) - \eta$. This is indeed negative (using the fact that $p_2 - \mu_2 = (1-q)(p_2 - .5)$ and $\alpha_1(p_1 - .5) = q\eta$) and becomes more negative when η increases. This proves the proposition. ■

Proof of Proposition 5: Let, wlog., the states be renumbered so that $\beta_1 \geq \beta_2 \geq \beta_3$ (with $\beta_k = \alpha_k(p_k - .5)$) and the decision choices be renamed so that $Z_1 = A$. Figure 4 shows the optimal outcomes in function of the signal vector θ, the parameter values, and whether the setting is supermodular or not.

Consider first the *supermodular* case and assume that the decisions have been renamed so that all $\theta_{k,l} = C$.

[26]The payoff of 'both always choose B' increases as μ_2 decreases, but that equilibrium is never selected by the equilibrium selection criterium.

θ	Both	Supermodular			Non-Supermodular
	$\eta \leq \frac{\beta_3}{2}$	$\frac{\beta_3}{2} < \eta \leq \frac{\beta_2}{2}$	$\frac{\beta_2}{2} < \eta \leq \min\left(\frac{\beta_1}{2}, \frac{\beta_2+\beta_3}{2}\right)$	$\min\left(\frac{\beta_1}{2}, \frac{\beta_2+\beta_3}{2}\right) < \eta$	$\frac{\beta_3}{2} < \eta$
AAA	AAA	AAA	AAA	AAA	AAA
AAB	AAB	AAA	AAA	AAA	AAB
ABA	ABA	ABA	AAA	AAA	ABA
ABB	ABB	ABB	ABB	AAA or BBB	ABA
BBB	BBB	BBB	BBB	BBB	BBB
BBA	BBA	BBB	BBB	BBB	BBA
BAB	BAB	BAB	BBB	BBB	BAB
BAA	BAA	BAA	BAA	AAA or BBB	BAB

Figure 4: Optimal actions for $K = 3$ in function of parameters and whether the setting is supermodular or not

If the signal vector $\theta = AAA$ then there is no need to announce a strategy and the expected payoff is $\alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + 3\eta$. If $\theta = ABB$ then the piecemeal solution gives an expected payoff $\alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 - \eta$. The (only) potential ways to obtain a higher payoff (through strategy) are either by choosing $D_1 = \overline{Z}_1$, i.e., by switching D_1 from the piecemeal solution (at cost $2\beta_1$), or by choosing both $D_2 = \overline{Z}_2$ and $D_3 = \overline{Z}_3$, i.e., by switching both D_2 and D_3 (at cost $2\beta_2 + 2\beta_3$). There are thus two cases to consider. In the case that $\beta_1 \geq \beta_2 + \beta_3$, alignment – if optimal – is best obtained by switching both D_2 and D_3. That switch improves the payoff if $\alpha_1 p_1 + \alpha_2(1-p_2) + \alpha_3(1-p_3) + 3\eta > \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 - \eta$ or $\eta > \frac{\beta_2+\beta_3}{2}$. So if $\eta > \frac{\beta_2+\beta_3}{2}$ then all decisions should align with Z_1, while if $\eta \leq \frac{\beta_2+\beta_3}{2}$ then the piecemeal outcome is optimal. In the alternative case that $\beta_1 \leq \beta_2 + \beta_3$, alignment is optimally obtained by switching D_1. That switch improves the payoff if $\alpha_1(1-p_1) + \alpha_2 p_2 + \alpha_3 p_3 + 3\eta > \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 - \eta$ or $\eta > \frac{\beta_1}{2}$. So if $\eta > \frac{\beta_1}{2}$ then D_1 should align with D_2 and D_3, while if $\eta \leq \frac{\beta_1}{2}$ then the piecemeal outcome is optimal. If $\theta = ABA$ then alignment – if optimal – is best obtained by switching D_2 to $\overline{Z}_2$ (which, at cost $2\beta_2$, always dominates switching both D_1 and D_3 at cost $2\beta_1 + 2\beta_3$), which improves the payoff when $\alpha_1 p_1 + \alpha_2(1-p_2) + \alpha_3 p_3 + 3\eta > \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 - \eta$ or $\eta > \frac{\beta_2}{2}$. If $\theta = AAB$ then alignment is optimally obtained by switching D_3 (which always dominates switching both D_1 and D_2), which is worthwhile when $\eta > \frac{\beta_3}{2}$. All other cases are symmetric.

Consider next the *non-supermodular* case. By renaming decision choices (switching A and B), any of the three interactions can be made the substitute with the other two complements. Assume that decision choices have been renamed so that $\theta_{1,2} = \theta_{1,3} = C$ and $\theta_{2,3} = S$ and so that $\theta_1 = A$. In this case, at least one of the interactions is always violated. If $\theta = AAA$, then there is no gain from switching from the piecemeal solution and thus no gain from strategy. The payoff in this case is $\alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \eta$. The same is true for $\theta = AAB$ and ABA, which thus give identical payoffs. When $\theta = ABB$, then all interactions are violated and the piecemeal solution gives payoff $\alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 - 3\eta$. A higher payoff can potentially be obtained by switching (exactly) one decision. Since any switch has the same effect on the interaction payoffs, the best decision to switch (if switching is optimal) is D_3. This switch improves the payoff if $\alpha_1 p_1 + \alpha_2 p_2 + \alpha_3(1-p_3) + \eta > \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 - 3\eta$ or $\eta > \beta_3/2$. All other cases are symmetric.

Take now all cases (supermodular and non-supermodular) together. If $\eta \leq \beta_3/2$ then there is never any gain from strategy. If $\eta > \beta_3/2$, then the expected gain from strategy for the non-supermodular case is always $(4\eta - 2\beta_3)/4 = \eta - \beta_3/2$ where the division by 4 captures the fact that the likelihood that strategy improves the payoff in the non-supermodular case is 1/4. The gain from strategy for the supermodular case is $(4\eta - 2\beta_3)/4 = \eta - \beta_3/2$ if $\beta_2/2 \geq \eta > \beta_3/2$; it is $2\eta - \frac{\beta_2+\beta_3}{2}$ if $\min(\frac{\beta_2+\beta_3}{2}, \frac{\beta_1}{2}) \geq \eta > \frac{\beta_2}{2}$, and it is $3\eta - \frac{\beta_2+\beta_3}{2} - \min\left(\frac{\beta_2+\beta_3}{2}, \frac{\beta_1}{2}\right)$ if $\eta > \min(\frac{\beta_2+\beta_3}{2}, \frac{\beta_1}{2})$. The likelihood that strategy improves the payoff is identical for the supermodular and non-supermodular cases when $\eta \leq \beta_2/2$ and strictly higher for the supermodular case than for the non-supermodular case when $\eta > \beta_2/2$ (either 1/2 or 3/4 versus 1/4). This proves the proposition. ■

Proof of Proposition 7: Let the states be numbered such that D_1 is the decision with 2 interactions and such that $\eta_{1,2} \geq \eta_{1,3}$, as indicated in Figure 5. Throughout the analysis, it will never be necessary for the

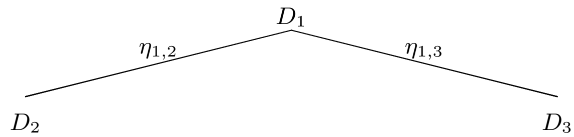

Figure 5: Setup for centrality analysis, $\eta_{1,2} \geq \eta_{1,3}$

strategist to fix any decisions. It can indeed be verified that in all cases, the optimal outcome is implemented by the equilibrium selected (by fictitious play) for the subgame starting in 2c.

Consider first the case that $\beta < \eta_{1,3} (\leq \eta_{1,2})$. Since it is always better to compromise a decision than to violate an interaction, the optimal outcome will always satisfy both interactions. Moreover, with all decisions equally important, it will do so in the way that minimizes the number of decisions to be compromised. Since both interactions can always be satisfied by compromising at most one decision, that minimum number of decisions is thus either zero (when the piecemeal solution satisfies both interactions) or one (when it doesn't).

It follows from the above that the following is an optimal (pattern of investigation and) strategy and thus a potential equilibrium. (Moreover, together with the symmetric process where D_2 and D_3 are switched in roles throughout, these are the only possible optimal (pattern of investigation and) strategies and thus the only possible potential equilibria.) First, investigate T_1, T_2, and $T_{1,2}$. If Z_1 and Z_2 respect $\theta_{1,2}$ then announce as strategy $D_1 = Z_1$. If that is not the case, investigate T_3 and $T_{1,3}$. Then make *no* announcement in one of the two possible outcomes (i.e., either make no announcement whenever Z_2 and Z_3 do respect $\theta_{2,3}$ or make no announcement whenever they do not respect $\theta_{2,3}$) and announce (any) one of the optimal decisions (D_1, D_2, or D_3) in the complementary outcome. To see that this indeed leads to the optimal outcome, note the following. Whenever D_1 is announced, the optimal outcome obtains because announcing D_1 makes immediately clear what is optimal for the two other decisions. When either no announcement is made or a decision other than D_1 is announced, each player can infer that $\theta_{1,2}$ is not respected by Z_1 and Z_2 and the corresponding inference on $\theta_{2,3}$. With that inference and their own local information, each participant can derive the optimal set of decisions, and the optimal outcome obtains.[27] Decision D_1 is indeed more likely to be part of the strategy than any other decision (weighing all equilibria equally).

Consider next the case that $\eta_{1,3} < \beta < \eta_{1,2}$. In that case, the optimal outcome will always satisfy $\theta_{1,2}$. If Z_1 and Z_2 satisfy $\theta_{1,2}$, then the piecemeal solution is optimal. If that is not the case, then either D_1 or D_2 will be compromised in such a way that *both* $\theta_{1,2}$ *and* $\theta_{1,3}$ are satisfied (which is always possible with compromising at most one of the two). It follows then that the following is an optimal (pattern of investigation and) strategy. First, investigate T_1, T_2, and $T_{1,2}$. If Z_1 and Z_2 respect $\theta_{1,2}$ then announce no decision (so that the strategy is empty). If that is not the case, investigate T_3 and $T_{1,3}$. For the announcement that follows this last investigation, there are multiple possibilities that all lead to the optimal outcome and each is an equilibrium (absent further refinements). Any communication pattern that satisfies the following conditions works: 1) exactly one decision is announced and that decision must be part of the optimal outcome, 2) one of the following two holds: a) the decision announced is different when $\theta_{1,3}$ is satisfied than when $\theta_{1,3}$ is violated *or* b) the decision announced is either D_1 or D_2. The argument is analogous to above. It is also again straightforward to verify that D_1 is weakly more likely to be part of the strategy than any other decision (weighing all equilibria equally). This proves the proposition for this second parameter range.

Consider finally the case that $\eta_{1,2} < \beta < \eta_{1,2} + \eta_{1,3}$, which implies that compromising a decision is only optimal if that makes both interactions go from violated to satisfied (which is only possible for D_1). In that case, the optimal outcome is the piecemeal solution *unless* compromising D_1 satisfies both $\theta_{1,2}$ and $\theta_{1,3}$. It then follows that the following is an optimal (pattern of investigation and) strategy. Investigate T_1, T_2, and $T_{1,2}$. If Z_1 and Z_2 respect $\theta_{1,2}$ then announce no decision (strategy is empty). If that is not the case, investigate T_3 and $T_{1,3}$. If Z_1 and Z_3 respect $\theta_{1,3}$, then announce again no decision (strategy is empty), else announce as strategy either $D_1 = \overline{Z}_1$, or $D_2 = Z_2$ or $D_3 = Z_3$. D_1 is in this case equally likely – and thus

[27] This equilibrium requires a lot of 'coordination' on the meaning of particular messages and can be excluded by extensions as discussed in Section 3. The resulting equilibria would be more logical and attractive and make D_1 more often the equilibrium announcement. But as it would not change anything to the results and propositions in the main body of the paper, it didn't seem worth adding this refinement to the model.

weakly more likely – to be part of the strategy than any other decision. This completes the proof. ■

References

Andrews, K. (1971): *The Concept of Corporate Strategy*. Dow-Jones Irwin, Homewood IL.

Andrews, K. R. (1987): *The Concept of Corporate Strategy*. Irwin, Homewood IL.

Barney, J. B. (2011): *Gaining and Sustaining Competitive Advantage*. Prentice Hall, New Jersey.

Bolton, P., and M. Dewatripont (1994): "The Firm as a Communication Network," *Quarterly Journal of Economics*, 109(4), 809– 839.

Bower, J. L. (1970): *Managing the Resource Allocation Process*. Harvard Business School Press, Boston MA.

Bower, J. L., C. A. Bartlett, H. E. Uyterhoeven, and R. E. Walton (1995): *Business Policy: Managing Strategic Processes*. Irwin McGraw-Hill, Boston MA.

Brandenburger, A. M., and H. W. Stuart (1996): "Value-Based Business Strategy," *Journal of Economics and Management Strategy*, 5(1), 5–24.

Burgelman, R. A. (1994): "Fading Memories: A Process Theory of Strategic Business Exit in Dynamic Environments," *Administrative Science Quarterly*, 39, 24–56.

Casadesus-Masanell, R., and J. E. Ricart (2010): "From Strategy to Business Models and onto Tactics," *Long Range Planning*, 43, 195–215.

Chandler, A. D. (1969): *Strategy and Structure: Chapters in the History of the American Industrial Enterprise*. MIT Press, Cambridge MA.

Collis, D. J., and M. G. Rukstad (2008): "Can You Say What Your Strategy Is?," *Harvard Business Review*, 86(4), 82–90.

Coyne, K. P., and S. Subramaniam (1996): "Bringing Discipline to Strategy," *McKinsey Quarterly*, 32(4), 14–25.

Crémer, J. (1993): "Corporate Culture and Shared Knowledge," *Industrial and Corporate Change*, 3(3), 351– 386.

d'Aspremont, C., J. J. Gabszewicz, and J.-F. Thisse (1979): "On Hotelling's Stability in Competition," *Econometrica*, 47(5), 1145–1151.

Dessein, W., A. Galeotti, and T. Santos (2012): "Rational Inattention and Organizational Focus," Working Paper.

Dessein, W., and T. Santos (2006): "Adaptive Organizations," *Journal of Political Economy*, 114(5), 956–995.

Drucker, P. (1973): *Management: Tasks, Responsibilities, Practices*. Harper & Row, New York.

Fudenberg, D., and D. K. Levine (1998): *The Theory of Learning in Games*. MIT Press, Cambridge, MA.

Garicano, L. (2000): "Hierarchies and the Organization of Knowledge in Production," *Journal of Political Economy*, 108(5), 874– 904.

Geanakoplos, J., and P. R. Milgrom (1991): "A Theory of Hierarchies Based on Limited Managerial Attention," *Journal of the Japanese and International Economies*, 5(3), 205–225.

Ghemawat, P. (1987): "Adolph Coors in the Brewing Industry," Harvard Business School Case 388-014.

——— (1991): *Commitment: The Dynamic of Strategy*. The Free Press, NY NY.

Hambrick, D. C., and P. A. Mason (1984): "Upper Echelons: The Organization as a Reflection of its Top Managers," *Academy of Management Review*, 9, 193–206.

Hurwicz, L. (1973): "The Design of Mechanisms for Resource Allocation," *American Economic Review*, 63(2), 1–30.

Kiechel, W. I. (2010): "Seven Chapters of Strategic Wisdom," *strategy+business*, 58.

Levinthal, D. A. (1997): "Adaptation on Rugged Landscapes," *Management Science*, 43(7), 934–950.

Lippman, S. A., and R. P. Rumelt (2003): "A Bargaining Perspective on Resource Advantage," *Strategic Management Journal*, 24(11), 1069–1086.

MacDonald, G., and M. D. Ryall (2004): "How do Value Creation and Competition Determine Whether a Firm Appropriates Value?," *Management Science*, 50(10), 1319–1333.

Mailath, G. J., V. Nocke, and A. Postlewaite (2004): "Business Strategy, Human Capital, and Managerial Incentives," *Journal of Economics*, 13, 617–633.

Marschak, J., and R. Radner (1972): *Economic Theory of Teams*. Yale University Press, New Haven, CT.

Milgrom, P., and J. Roberts (1990): "The economics of modern manufacturing : Technology, strategy, and organization," *American Economic Review*, 80(3), 511– 528.

——— (1992): *Economics, Organization and Management*. Prentice Hall, Upper Saddle River NJ, Englewood Cliffs, New Jersey.

Mintzberg, H. (1987): "The Strategy Concept I: 5 Ps for Strategy," *California Management Review*, 30, 11–24.

Mintzberg, H., and J. A. Waters (1985): "Of Strategies, Deliberate and Emergent," *Strategic Management Journal*, 6, 257–272.

Porter, M. E. (1980): *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. The Free Press, NY NY.

——— (1996): "What is Strategy?," *Harvard Business Review*, 74, 61–78.

Prat, A. (2002): "Should a Team be Homogenous?," *European Economic Review*, 46(7), 1187–1207.

Puranam, P., and M. Swamy (2011): "Expeditions without Maps: When are Faulty Initial Representations Useful in Coupled Learning Processes?," Working Paper.

Rivkin, J. W. (2000): "Dogfight over Europe: Ryanair (A)," Harvard Business School Case 700-115.

——— (2002): "An Options-led Approach to Making Strategic Choices," Harvard Business School Case 702-433.

Rivkin, J. W., and N. Siggelkow (2002): "Organizational Sticking Points on NK Landscapes," *Complexity*, 7(5), 31–43.

Rivkin, J. W., and N. Siggelkow (2003): "Balancing Search and Stability: Interdependencies Among Elements of Organizational Design," *Management Science*, 49(3), 290– 311.

Rotemberg, J. J., and G. Saloner (1994): "Benefits of Narrow Business Strategies," *American Economic Review*, 84(5), 1330– 1349.

——— (1995): "Overt Interfunctional Conflict (and its reduction through business strategy)," *Rand Journal of Economics*, 26(4), 630– 653.

Saloner, G., A. Shepard, and J. Podolny (2001): *Strategic Management*. John Wiley & Sons, New York, book draft : New York : John Wiley & Sons.

Siggelkow, N. (2002): "Misperceiving Interactions Among Complements and Sustitutes: Organizational Consequences," *Management Science*, 48(7), 900–916.

Simon, H. (1947): *Administrative Behavior*. Free Press, New York.

Topkis, D. M. (1998): *Supermodularity and Complementarity*. Princeton University Press.

Van den Steen, E. (2010): "Culture Clash: The Costs and Benefits of Homogeneity," *Management Science*, 56(10), 1718–1738.

Van den Steen, E. (2012): "The Role of Leaders in Strategy Formulation," HBS Working Paper.

Van Zandt, T. (2003): "Real-Time Hierarchical Resource Allocation with Quadratic Payoffs," Working Paper INSEAD.