In the grand scheme of things... all is the same.

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Thinking big and small are part of our everyday lives. When a pandemic hits the world, we worry about macroeconomic factors and how they might affect our livelihoods and those of others. However, when we wake up, we not only go through morning routines but also start thinking about what's going to happen next. What to wear today? Is there traffic on the way to work? How creative do we become in our responses to these questions?

In psychology, construal level theory argues that when we are thinking about psychologically distant elements of life, we tend to think big, evaluate according to how desirable this element is, and we think imprecisely. Some factors which contribute to the psychological distance are temporal, spatial, and social distances. You might realize that when you are planning a holiday in far future, your choices may become more creative and exotic, as well as quite expensive. At that moment, you do not know whether this holiday is doable at all, but it doesn't hurt to dream, right? Meanwhile, if elements become psychologically proximate, then we tend to think less big, evaluate according to how feasible this element is, and we think more accurately. Oftentimes, the confusion which arises during choosing what to wear is due to the fact that we can think of many options and we can think of many combinations at the same time. On top of that, we start thinking whether one color goes with the other and so on. This is a world where thoughts are more detailed and many more decisions have to be made.

When it comes to business

What I would like to point out here is that we are capable of thinking small and big all time, about everything, and can switch between them rapidly. While this certainly has some implications for our everyday lives, how we interact with others and the society, I want to raise the bets: There are many managers at different levels of an organization out there who are making decisions almost every work day; to do this, they also think small and big. They might be thinking about the consequences of an investment which will pay off in several years (for example capacity expansion in oil industry may payoff only in 20-25 years!). Some others such as marketing directors may be thinking about how to conduct an advertisement campaign in the coming month.

What is intriguing about this is that individuals adapt to the necessities of their environment; they think small and big and learn to think that way only if

necessary. Hence, a CEO of a multinational may be thinking big when it comes to managing external stakeholders spread around the world, but thinking small when it comes to guiding colleagues through a strategic pivot as it requires internal coordination. However, an individual at a manufacturing plant will be less concerned about the strategic positioning of a firm. While this employee will know a lot more about the specifics of ,for example, producing a car than the CEO does, the CEO will have a much bigger overview of the development of automotive industry.

The question that I would like to discuss shortly is what implications this might have for the perceptions of decision makers; I would like to do it with a simple mathematical model which is a simplified version of what we know as renormalization theory in physics. More specifically, given a dynamic process which switches between two states A and B, how do individuals thinking in concrete fine-grained terms differ in their perception from those who have to think big, yet abstract and coarse-grained?

Of course, the simplest answer is that those who think more abstractly miss out on knitty-gritty details which may be essential. I heard from many individuals who face customers at work or work on the field (whether factory or sales) that their bosses do not have a clue about what is going on. However, this should be balanced to some extent with the fact that bosses are there to manage and guide, not to know the details. Nevertheless, I would like to zoom in on this tension and draw some implications with a simple exercise; I hope thinking small will reveal some nuanced picture, which may survive into our picture of doing business in the grand scheme of things.

Investing in Simple World

I will introduce some simple probability language to explain the differences; let's set up a hypothetical world first and ground it in financial markets as an example: In this imaginary world, the markets can be only in high and low states (H and L respectively). So the dynamics of this simple market is described by the markets either staying in the given state (H $\rightarrow$ H, L $\rightarrow$ L) or changing its state (H $\rightarrow$ L, L $\rightarrow$ H). I will assign some probability for each of these changes. Say that markets tend to stay at the higher state for shorter times, meaning H $\rightarrow$ H has low probability of p_{HH}. It will switch away to L with probability p_{LH}. Similarly, market has high probability of staying low p_{LL} and will switch to high state with probability p_{HL}. Moreover, I also assume that there is no memory effects or anything (as some knowledgeable finance professional may oppose). In technical terms, I simply set up a two state Markov model.

Given this reality, imagine that you are an active fund manager and observe these dynamics everyday; you collect data, analyze them, make predictions and invest accordingly. Your boss, meanwhile, wonders whether you are doing a good job or not, but is too busy to analyze the data as frequently nor think about it as rigorously. So, let's say that she takes a look at the data only 1 time for every N times you took a look. Can you already imagine how your boss' and your understanding of the markets will differ?

I would like to put it in formal terms. For those who are technically knowledgeable, I would like to point out that there might be many more complex outcomes when we move away from a simplified two state world, but bear with me through this analysis. Also, derivations of my formal results are shared at the end of the post. Assuming that you have the most accurate picture, you will estimate the probabilities (p_{HH}, p_{HL}, p_{LH}, p_{LL}) correctly. Your boss taking a look at these dynamic less frequently will have a different picture: Say, she observed the market every second day (this would be actually a micro-manager, which is not objectively bad). In two days, the market had the chance to move twice; they might have stayed the same twice, changed once, or changed twice! Imagine that the market was in high state in day 0 and ended up at low state in day 2; what paths are possible?

There are two ways for this: 1) Market stayed the same and then changed. 2) Market changed and stayed the same. For the first option, we see that the probability to stay the same is p_{HH} and changing is p_{LH}, product of which is $p_{HH} \times p_{LH}$. Similar logic leads to a probability of $p_{LH} \times p_{LL}$ for the second option. While you can distinguish these paths and probabilities, your boss cannot! It is much more likely that the market first changed and then stayed the same, making an early investment disadvantageous compared to the situation if the other option took place. Your boss will probably think that you should have done the early stage investment.

Formalizing abstraction

Now, what we can mathematically show is that as the frequency of your boss' inquiry decreases, the more independent the two states of the market look to the boss. Mathematically speaking, probabilities formalized below describe your boss' belief on in which state the market will be in any given time, independent of the previous state:

$$p_H = \frac{1 - p_{LL}}{2 - p_{HH} - p_{LL}}, \;\; p_L = \frac{1 - p_{HH}}{2 - p_{HH} - p_{LL}}. \tag{1}$$

Actually, if markets stayed at high state for 20% of the time and low for 85% of the time, then a boss looking at the data every second day would already think that the market states are uncorrelated and happen randomly (error would be less than 1%). We see that on one hand there is a fund manager who is aware of temporal correlation between market states and, on the other, a boss who thinks there are no correlations. This raises important questions for strategy making, strategy implementation and organizational design, which I will discuss in later sections. I would like to draw your attention to something hidden in this picture next.

Previous terms can be rewritten as

$$p_H = \frac{1}{1 + \frac{1-p_{HH}}{1-p_{LL}}}, \;\; p_L = \frac{1}{1 + \frac{1-p_{LL}}{1-p_{HH}}}. \tag{2}$$

Only the ratio $r = (1 - p_{LL})/(1 - p_{HH})$ matters for describing how the boss will perceive the market dynamics. This is important for two reasons:

1. Your boss can have one (rather false) perception, yet can justify its application to many markets, all of which have the same ratio r. This is the generalizable knowledge which comes with abstraction. The model implies that as abstraction grows, the number of market covered also grows.

2. Investment companies operating in different markets which are inherently different from each other may still have bosses who think exactly the same way. It is not that they are not smart nor wrong, but that they build perceptions of their markets based on data collected in different time intervals.

Especially as strategy scholars we are continually interested in explaining where heterogeneity in markets comes from. A long-standing literature shows the importance of how managers may differ from each other and how they may lead to completely different strategic outcomes, even if the companies have the same resources. This conclusion, on the other hand, suggests that different resources may lead to similar perceptions of the markets.

Formalizing concretization

Before moving on to the managerial implications of this analysis, I would like to turn the scope around. Imagine you received a promotion. You know how frustrating it is to have a boss who does not know as much as you, so you do not want to be like your previous boss. You hold on to your previous data collection and analysis routines in a superhuman way and have to also manage an individual who will assist you on this. However, given that this new assistant is specifically hired to conduct investments for you and has much more time to do market analysis, she actually analyzes the data twice your speed! Now you wonder: "Given what I am observing, what could there be that my assistant knows that I do not?"

Unfortunately, mathematics says that you can only wonder, but not figure it out. Information theoretical dynamics actually forbid you from figuring this out: You are as knowledgeable as the granularity of your data. Nevertheless, let's walk through the thought process involved in attempting to figure this out.

You think, "OK, my assistant collects data twice as often as I do. So, what she has in mind should simply be two-step extensions of what I have in mind, just like my former boss did." So, you now contemplate of a world where there are many probable outcomes in the two steps. Formal analysis says that you will have infinitely many worlds which could satisfy the market conditions that *you* are observing.

First analysis shows that if the probabilities of the market staying the same is not the same for high and low states, it is not possible to find an underlying process which will preserve the high vs low dichotomy (it is of limited use even if the probability is the same, see references). The issue becomes more critical

when your observations are not simply the result of a coarse-graining procedure (thinking big procedure). New data means shift in thinking sometimes.

This shift in thinking can be quantified as saying that we have to think more elaborately, or more concretely/specifically as psychology literature would suggest. Instead of classifying states of market as high and low, we may want to start thinking terms of markets being in states of "high after high", "high after low, "low after high, "low after low"; we expand from a world of two dimensions to four. As we cannot observe the intermediary steps, we will eventually have to do some conceptual coarse-graining: For example, we have to assume that low observations in our data are the bunched up cases of "low after high" and "low after low".

According to this expansion we can find some formal relationships which would define all processes at the assistant's level of observation that are consistent with our observations. While I do not have any mathematical completeness of my suggestions, we see that even simple rules can offer many potential explanations. The end results describing some solutions are as following

$$p_{CC} = \frac{p_{AA} - \alpha}{1 - \alpha} \tag{3}$$

$$p_{BB} = \alpha + (1 - \alpha)p_{DD} \tag{4}$$

$$p_{DD} = \frac{p_{LL} - 1 + p_{HH}(1 - \alpha)}{p_{HH}(2 - \alpha) - 1} \tag{5}$$

$$\alpha = \frac{p_{LL} - p_{HH}}{1 - p_{HH}} \tag{6}$$

where A corresponds to "high after high", B to "low after low", C to "low after high", and D to "high after low". What is important here is that p_{AA} is left undefined: As long as the equations satisfy probabilistic constraints, this parameter can take any value and the underlying 4 state model will be consistent with the 2 state model you would have in mind. Just like you knew exactly p_{HH} and p_{LL} while your boss knew only the ratios, your assistant knows p_{AA}, high after high probability, which you do not.

What does all of this mean for strategy?

Strategic implications

Apart from the frustration that the knowledge differences cause to employees or managers, how world is conceptualized has direct impact on different facets of strategy.

First, strategy making relies directly on how individuals in an organization perceive themselves and others. It is both academically and non-academically accepted that each level of an organization requires a different level of abstraction from its members. Managers think and communicate accordingly in different levels of abstraction. This analysis demonstrates a strategic trade-off between accuracy and flexibility. From accuracy point of view, false estimations

or expectations will lead to poorly set goals leading to quick failure of the organization. However, without enough generalizable knowledge firms will rely on specific perception of the world, which does not tend to stay stable for long times.

More concretely imagine that the probabilities regarding market state changes oscillated in an unpredictable way. The unpredictability may be due to lack of knowledge which is simply just not possible to acquire. In such times, coarse-graining actually suggests that as long as markets oscillate along the same r ratio as quantified above the knowledge will still be valid; less accurate, but valid. Management literature has established that such turbulent environmental conditions indeed favor "simple rules", general hence flexible enough rules which offer sufficient guidance.

This analysis also attracts our attention to bottom-up and top-down approaches to strategy implementation. Especially when organizations decide to decentralize, decrease levels of hierarchy and expanding the breadth of lower levels, they tend to enable more bottom-up approaches. This is in accordance with the simple rules approach. Top-down approach, on the other hand, was handled as the "promotion" case; how can a manager having less access to concrete granular data can set a strategic course for those who know more?

One aspect that was not covered here is the implication of coarse-graining on managers' perception who have to integrate information across different departments. In our analysis, data driven aggregation (which was quantified by how often the boss analyzed the data herself) was accompanied by conceptual aggregation (assuming high after low and high after high states of markets are the same). We see that conceptual aggregation can be extended to incorporate such effects as well. Conceptual aggregation not only connects disparate states and parts of the world, but also allows us to transfer new ideas from one domain to the other. Having a broader perspective, managers can actually correct the false perceptions of their employees as they are able to consider alternative scenarios consistent with their mindsets.

In light of these observations, top-down approaches may be useful in times of stability where information can be transferred across levels and new ways of doing things can be established without concerns of performance. Although it is known that such hierarchic structure prevail in extreme crisis times as well, it should be investigated whether this is true for systems which have been also in hierarchical influence in non-crisis times (hence have established routines and rules) or whether a quick adaptation into hierarchical order can be as effective. Research on dynamic capabilities of organizations suggests that they may come in complex routines, which regulate other routines; it takes time and practice to establish such routines, as exemplified by their presence in militaries.

Just as top-down guidance is important for coordination across the organization, organizational structures are also important for achieving this, incentive systems being one of them. As mentioned earlier, incentive systems are placed according to expectations or aspirations. A boss thinking that the market state is random may not set any incentives for an employee in charge of investments; after all the market is random. Meanwhile, knowing that there are temporal

correlations across market states would suggest that individuals should be incentivized to extract them and act accordingly. This poses a paradox: How do you know enough that there are correlations, yet maintain the abstraction? Or in other words, how can those who do not have enough granular knowledge about a task can set the payoff for a more knowledgeable individual to accomplish it? While agency theory tries to explain this question, and management literature further expands the discussion to perceptions, granularity of knowledge requires more attention.

Strategy research tries to explain to a great extent where competitive advantage comes from. I would like to point out that this analysis suggests that we should look more at the lower levels of an organization if we would like to see more heterogeneity in organizational practices. Different practices in lower levels may aggregate to a higher level in such a way that the managers perceive their companies similar to others, even if they are quite distinct. While notion of "best-practices" is not very useful for competitive advantage (as it does not add value against those other who would also adopt the *best* practice), granularity perspective would argue that best practices only set the r ratio quantified above, but not the specifics. Hence, adopting an accounting practice or organizational structure may be beneficial across all organizations, but the analysis casts doubt on whether they are implemented the same way; probably only in managers' minds. This problem is often faced when an organization adopts a new technology as best practice as such technologies are not put into practice in the best way.

Question of where the optimal level of abstract thinking lies has impact on many other facets of strategy. In this post, I wanted to cover only some questions. Next, I mention some perspectives on the same phenomenon from other disciplines as well which underlines the importance of this concept.

Cross disciplinary perspectives

Mentioning management, psychology, and physics in the same text points to an important observation: Many fields are dealing with the question of how does coarse-graining/abstraction/generalization (and many other terminology describing the same concept) matter.

In economics, we find role of prices as the operator which aggregates (hence coarsens) information through a collective mechanism. Similarly, many organizational economists have looked into emergence of hierarchies as solutions to bounded rationality. While their picture addresses limitations to computation and memory, this approach could be pressed further by taking into account the heterogeneity of the perceptions of agents. Meanwhile, organizational economists have discussed principal-agent problem and offered variety of ways of tackling the problem of setting incentives. However, setting the correct incentive schema requires accurate understanding of the state of the market.

Meanwhile, in psychology we see that construal level theory has been tackling the problem of how abstraction emerges. They offer novel perspectives on how people conceptualize the world, what implications it might have for mo-

tivation, emotions, and decision-making. These contributions have found their way into organizational studies and constitute a firm ground for further research extending the findings into other parts of management.

In sociology, aggregation problem is a foundational one. Not only from statistical point of view, but also from process perspective aggregation should matter. Research on categories suggests that the language we use is greatly shaped by generalizations (in psychological terms stereotyping) and has direct impact on the success of social movements or success of firms in markets. Claiming membership in a group or referring to generally accepted social labels play strategic role while navigating through any social space.

In computer science, analysis at different levels have been present for a while now, especially considering clustering, data compression, and many other machine learning models. Recently, hierarchical reinforcement learning applied in deep neural networks has caught my attention; several papers have shown the importance of having a "manager" and an "agent", where former makes decisions at a higher abstract level than the agent, which has to determine set of actions to achieve such goals. Such methods seem to prevail especially in unfamiliar settings, which emphasizes the strength of abstraction once again as argued above.

Last but not least, in physics, we see that aggregation is not the exception but the norm. Physicists currently still strive for the theory which can map the dynamics found in quantum levels to the universe level. While there are many contesting theories for this, even (or especially?) less extensive domains deal with this problem. Explaining atoms' and electrons' interactions in materials requires understanding of how particles' interaction should and can be aggregated to higher levels of physical scales. Renormalization group theory, which underlies the ideas pursued and presented in this post, has been developed to understand what consequences interacting states of particle collections may have at much higher scales.

Pursuit of understanding abstraction/generalization/coarse-graining across different domains suggests not only that it may be fruitful for research, but also that it is highly relevant for any practitioner. Strategy requires thinking small and big. Sometimes thinking too big will have its costs, some other times thinking too small. Expressing big and small thoughts will sometimes signal power, sometimes reliability (or lack thereof). In the grand scheme of things, everything might be justifiable and everything may be governed by the same principles. However, knowledge of when to look at the big picture and when to look at the small picture is an elusive one, which may have great impact on organizations' success.

Acknowledgement

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