

Money as a social coordination mechanism to  
fairly express our free material preferences

Johannes Reich, [johannes.reich@sophoscape.de](mailto:johannes.reich@sophoscape.de)

I dedicate this book to my wife Christine.

August 4, 2021



# Contents

<b>1</b>	<b>Introduction</b>	<b>7</b>
<b>2</b>	<b>Networks of economic interactions</b>	<b>13</b>
2.1	The interaction perspective . . . . .	14
2.1.1	System actions and interactions . . . . .	14
2.1.2	Protocols . . . . .	17
2.1.3	Games in interactive form (GIFs) . . . . .	20
2.2	The subject perspective . . . . .	24
<b>3</b>	<b>How we decide</b>	<b>27</b>
3.1	Preferences . . . . .	28
3.1.1	Completeness . . . . .	30
3.1.2	Transitivity . . . . .	31
3.1.3	Context dependencies: to reconcile multiple preferences . . . . .	31
3.2	Utility . . . . .	34
3.2.1	Preferences that cannot be represented as utility . . . . .	35
3.2.2	Utility that cannot be maximized . . . . .	36
3.2.3	Interpersonal comparison of preference and utility . . . . .	38
3.3	Beyond the preference concept . . . . .	39
3.3.1	Intentions: the difference between spontaneous and selection decisions . . . . .	40
3.4	Summary . . . . .	41
<b>4</b>	<b>Money as a mechanism</b>	<b>43</b>
4.1	Brief historic consideration . . . . .	43
4.2	External coupling of buyer and seller: the trade . . . . .	46
4.2.1	Buyer . . . . .	46
4.2.2	Seller . . . . .	47
4.2.3	The trade . . . . .	47
4.3	Trader: Internal coupling of Buyer and Seller . . . . .	48
4.4	The traditional model . . . . .	49
4.5	Money as a utility transfer mechanism . . . . .	50
4.6	Money's coordinating function . . . . .	53
4.7	What we can and what we can't buy . . . . .	54

4.7.1	What we cannot buy – at least not directly . . . . .	54
4.7.2	What we can buy: different goods and their characteristics	56
4.8	Material wealth . . . . .	57
4.8.1	What does the gross domestic product (GDP) indicate? .	59
<b>5</b>	<b>Price determination</b>	<b>61</b>
5.1	Fair prices . . . . .	61
5.1.1	Fairness in 1:n relations . . . . .	61
5.1.2	Fairness today and tomorrow . . . . .	63
5.1.3	Privacy and robustness concerns . . . . .	63
5.1.4	A preliminary conclusion . . . . .	63
5.2	Maximizing collective utility: markets . . . . .	64
5.2.1	Collective trading . . . . .	64
5.2.2	The clearing function of markets . . . . .	66
5.2.3	Market failure: when markets don't function well . . . . .	66
<b>6</b>	<b>Trading labour: the working human</b>	<b>69</b>
6.1	A naive approach . . . . .	69
6.2	Recursive preferences . . . . .	70
6.3	Fair salaries . . . . .	71
6.4	Severance payments . . . . .	73
6.5	The consequences . . . . .	74
<b>7</b>	<b>The private public money distribution (PPMD) problem</b>	<b>75</b>
7.1	Equal or unequal power . . . . .	76
7.2	The relevance of the relation between our intentions and our effects	78
7.3	The problem of positive feedback and the 1:n problem . . . . .	79
7.4	The social intricacy of a world with money . . . . .	80
7.5	Towards a solution of the PPMD problem . . . . .	81
<b>8</b>	<b>Money and morals</b>	<b>85</b>
8.1	The indirect society: the mutual relation between values and culture and money . . . . .	86
8.2	Pareto-efficiency . . . . .	90
8.3	Egoism and beyond . . . . .	91
8.3.1	Crime and Punishment . . . . .	93
8.3.2	Pay-for-Performance . . . . .	93
8.3.3	Completeness of contracts . . . . .	94
8.4	Rationality . . . . .	94
8.5	The addictive potential of money as a reward . . . . .	96
8.6	A brief imagination on money distribution mechanisms . . . . .	99
<b>9</b>	<b>Concluding remark</b>	<b>101</b>

# Preface

I would like to thank Marvin Deversi and Leoni Bossemeyer who read several versions of this article and gave very valuable feedback. As I already indicated in a footnote, the proof of theorem (1) is due to Martin Härterich, a colleague of mine at SAP, who also discussed the matter of this article with me extensively. And finally, I would like to mention that it was my wife, Christine Reich, who had the idea to assign the term "valuation" also to the cost-term of the employee with respect to its work and thereby emphasizing the symmetric relation between the external valuation of the work by the employer and its inner valuation by the employee.

TBD



# Chapter 1

## Introduction

What is money? Dating back to the book of William S. Jevons *"Money and the Mechanism of Exchange"* [Jev75], money is defined in the pertinent economic literature over the last 160 years in terms of its general functions. The most often cited general functions seem to be: it works as a medium of exchange, a store of value, and a unit of account (e.g. [KW18], p. 323).

This is an interesting approach to define a concept. We should not call something "money" that does not fulfill certain functions – functions we have yet to agree on. That is, we define what we mean when we speak of "money" by the general functions it does fulfill. In this sense, the question "what is money?" aims at the most basic general functions, some thing should fulfill such that we can justifiably name it "money".

In this sense, money is not something that somehow exists and whose meaning for us remains invariant against the way we use it. Money, whose general function is to support accumulating wealth for a few at the expense of many others, is a different money than money whose general function is to express our free material preferences fairly in relation to others – although we cannot distinguish both sorts of money phenomenologically. Instead these differences depend on the money's context of usage.

This is the reason why I also speak about the *"meaning of money"* following Wittgenstein who understood the meaning of a word as its use in the language [Wit53]. This meaning of money is nothing fixed, somehow discoverable by some clever scientists alike the functions of electrons or photons once and for all. Instead, the meaning of money becomes determined by its societal context, the rules that determine its usage, which are all man-made and which represent in the best case some collective choice in the sense of an aggregation of our individual preferences on how we want to live.

So, trying to find an answer to the question "what is money?" we do touch very elementary aspects of our societal context, our preferences, and how to aggregate them and thereby we quickly become normative. The meaning of money actually divides into two aspects: What is money under which social circumstances, and especially under the current circumstances? And: what

model do we prefer, in the sense of which meaning do we want money to have?

In fact, money — as many other important cultural things — has appeared historically "somehow" spontaneously in very many different forms and shades because it was useful, long before people were able to understand what it actually is or better should be (for an overview on the history of money, see for example [Dav02]). In this respect, money is no exception, but the same happened to other important concepts like our mathematical concept of numbers, our linguistic concept of meaning, our physical concepts of matter, force and energy, our moral concept of justice, etc. And as such it seems to me that our concept of money is, even today, still a melange of archaic remnants and modern elements. As it was the case with the other concepts, whose handling were greatly influenced by our better understanding, I would expect the same for our concept of money.

To begin with: at first glance, we can state, that every money-based commodity transfer could actually happen without money, as a donation. The baker could donate his rolls to me, the supermarket the milk, cheese and bacon; then I could work gratuitously for my company and the travel agency could donate my most desired trip to me . . . .

This world would not work, even if we were all Jesus-like altruists. Why? How should the baker know whom to donate what? How does she know that I like rolls more than croissants? But only on workdays, not on weekends. And how should the supermarket know that it is better to give 500g of the Allgäu mountain cheese to me and 300g of the Italian Mortadella sausage to my neighbour. And why should I work gratuitously for my current company and not for another one? And what happens if we all like most to play computer games, or to hang around at the Copacabana? Who then makes the Allgäu mountain cheese or the Mortadella we find so tasty?

So, we need a social mechanism to distribute our limited material resources according to our individual preferences under fair consideration of all the other people's preferences and, simultaneously, to balance supply and demand. This is much more specific than just being "a mechanism of exchange". And it must scale almost indefinitely. And it must be robust against strategic manipulation. And it should provide as little private information as possible. Etc.

Doesn't this requirement profile reads a bit like a wish list for something magical? My proposition now is, that, depending on the existence of certain constraints, money could provide such a mechanism. But as with other really powerful "magic" things, we indeed have to know what we are doing to remain in the role of the sorcerer and not to slip into the role of the sorcerer's apprentice. Otherwise, it could, and in the current reality it does, provide a mechanism to create extreme, unprecedented inequality.

This book's aim is to stimulate a scholarly discussion within the state of the art context to advance the field of economics. I make some use of informatic concepts, especially in the treatment of interactions in chapter 2. But there is only one small part of the book, the proof of the main theorem 1, where more than elementary mathematics is needed. The book should therefore be readable also for non-economists willing to read thoroughly into a subject.

Its contribution is to show — based on well established microeconomic con-



cepts, complemented by a view on the (economic) subjects borrowed from informatics and inspired by sociology – that money can be a social coordination mechanism to express our free material preferences under fair consideration of all the other people’s free material preferences.

In chapter 2, I set the stage by introducing the basic concepts of interactions, autonomy, preferences and utility as they are used in economics. I dwell quite extensively on these notions, as an understanding especially of the utility concept and – very importantly – its limitations are, in my opinion, essential for our understanding what we can and what we can’t express with money.

The central problem I begin with is to find a balance between our description of a subject within a single social interaction and our description of a subject as a whole in all its social interactions. The essential idea is that a subject appears in a single social interaction not as a whole but as a ”role”, which can be understood as a projection of the subject onto this interaction. And these roles can couple, or compose, in two different, complementary, and equally important ways. They can couple *externally* by interaction or *internally* by coordination. With the role concept we give the subject an interaction-oriented internal structure and based on this structure we can say that a subject as a whole ”coordinates” all its roles.

Usually, social interactions are stateful and nondeterministic and thereby provide freedom for decisions. From an informatics perspectives, decisions in this sense are fictitious characters of an ”internal” input alphabet which complement the subject’s role in an interaction such that it becomes deterministic, that is, represents a function. We thereby can say that decisions determine the actions of a subject in an interaction. To talk about truly free decisions, we have to take the subject as a whole into account, because what appears as a decision within a single role of a subject in some interaction could in fact be determined by the coordination with other roles of the same subject. I name a decision of a subject to be ”truly free” only if it is not enforced by any of its interactions.

With the preference concepts, that is well known from microeconomics, we trace the difficult-to-observe decisions back to a concept that allows a simple empirical access. Our behavioural model thus becomes that we act as we want – or as we say in our theory, as we ”prefer” – in accordance with our expectation towards the rest of the world.

I call a preference *”material”* if it only relates to exchangeable goods that can be owned and transferred or to well enough defined services, both of which I subsume under the term ”commodity”. I call a material preference that is of relevance in a (trade) interaction *”free”* if it is the base of a free decision, that is, not enforced by another interaction of the same subject.

Building on that I introduce in chapter 4 money as a social coordination mechanism to fairly express our free material preferences. I base the construction of this possible general function of money on its ability to transfer utility in interactions between different subjects performing the roles of buyer and seller and on the invariance of the acquired utility of a subject as a whole, independent of the role in which it appears.

The essential twist is that the utility representation of the subject has to

remain valid also in the holistic view, where a subject internally coordinates both roles of a trade, buyer and seller. This requires the utility function of buyer not to include her total budget, as is traditionally assumed, but to be just the difference between the maximal amount of money she is willing to pay (her valuation) and her cost of buying (the price).

The total budget of an economic subject enforces a coordinating constraint on all its economic interactions, that is, on its acting as a whole, coordinating all its different roles.

I create money in the desired sense by requiring the total utility resulting from the trade as the sum of the utility of seller and buyer to be independent of the price. Additionally assuming equal budget and equal access to all economic relevant alternatives for all buyers, money becomes a utility-transfer mechanism where buyer with her valuation has a discretionary decision component.

According to this theory, material wealth becomes the sum of the valuations of commodities attributed by an economic subject and therefore a difficult concept in an absolute sense due to the subjective nature of this valuation. The amount of collective material wealth that can be accumulated by a social group becomes determined by the rates of valuation creation and perishing. Social stability guaranteeing valuation stability becomes an essential boundary condition.

In chapter 5, I describe the concept of fair prices which is directly implied by the concept of money as a utility-transfer mechanism in the sense that the total utility generated by the trade is partitioned 1:1 between seller and buyer.

However, because of several issues, most importantly the fairness ambiguity in the  $1 : n$ -problem, it seems unrealistic to achieve completely fair prices in every local trade — although completely unfair prices should certainly be avoided. To achieve global fairness therefore necessitates redistribution mechanisms in the sense to sustain the preconditions of the proposed money semantics, namely the approximately same total budget of all buyers.

While in a single trade the price does not — per definition — influence the generated total utility, this is different for collective trading at a single price. Treating the standard economic textbook price determination mechanism of markets, I show that markets do optimize collective utility — as long as the preconditions for the concept of an aggregated "total utility" are fulfilled, most notably that all buyers have the same budget. If these preconditions are not fulfilled, the numbers can still be aggregated, but they do not signify the preferences of the economic subjects any longer and therefore cannot be viewed as aggregated utility.

Then, I show in chapter 6 that if we express our preferences with money, trading labour is not the same as trading other commodities, like sugar. Instead, trading labour results in a discretionary component not only on the buyer's side (the employer) but additionally also on the seller's side (the employee). Together with a hierarchical preference for fairness, this results in a recursive preference relation on the seller side, the employee. As a result, labour markets cannot work the same way as markets for ordinary goods.

In chapter 7, I ponder over the question according to which principles should

we allocate money. In the use of money we should distinguish between changing the state of the world such that only our own preferences are affected (effectively private money) and those that relate to others (effectively public money). This is not the same as when I express egoistic preferences that relate exclusively to myself versus others, as I can change the state of the world from an exclusive egoistic perspective but this change nevertheless may also be important to other people. I call this money intentionally private vs. public money. It is actually not so easy to change the state of the world with money in effectively purely private terms in this sense. In a trade this requires either buyer to pay her valuation, leaving herself indifferent or to pay only seller's cost, leaving seller indifferent. So, obviously, the distinction between effectively private and public money is not a binary, but a graded one.

But nevertheless, I think that the distinction between intentional and effective as well as between public and private money is very important, as from an ethical perspective, the request for all people to be equal is a strong argument to provide everyone the same total budget only for money with effectively private character. However, for changing the state of the world such that it affects the preferences of other people, it seems to be wise to provide those people with more money who have shown a proven track record in handling this money indeed best in the public sense. As this property is a property of the context where we spent our money in and not of the money itself, this results in the private public money distribution (PPMD) problem that every egalitarian society has to solve.

In chapter 8, I discuss the mutual, strong but ambivalent relation between money and morals. I delineate that economics as a science is itself build upon profoundly moral premises, like the assumption of free decisions. And although we cannot buy peace, democracy, freedom or justice directly, the way we collectively use our money is a strong determinant of these things. From an economic point of view we live in an indirect society with a strong tie between money and values and culture. To unfold its economic potential, money depends on a stable culture of trust and the stability of a culture of trust depends on the kind of function, money fulfills. Depending on the circumstances, real money can strongly support our autonomy and thus be a strong pillar for an egalitarian society — but it can also be a source of incredible sorrow and grief that drags us all into the abyss. It is up to us as a society to decide which world we want to live in.

I also dwell on a couple of economic concepts which are or have been quite influential for economists to think about money. First, I discuss, why the concept of "Pareto-efficiency" did get such a wide range of acceptance in economics, despite the fact, that it does not insure equitable allocations in any sense and despite the fact, that it is a bad model for human decision taking. In line with Amartya Sen [Sen08] I argue that this was a direct consequence of the erroneous assumption of leading economists that interpersonal utility comparison cannot be performed. As the Pareto principle is very well suited to justify the economic status quo, this error had an enormous impact on the view of social justice within the scientific community of economists, culminating in Friedrich Hayek's

strange conviction, that the concept of social justice was "strictly empty and meaningless" ([Hay76], S. 68).

I show the concept of egoism not to be part of the concept of utility maximization but to be an additional simplifying assumption with respect to the structure of our preferences, namely not to value any state belonging to other people. Ignoring the validity boundaries of this concept leads to improper theories, whereof I provide three well known examples of crime and punishment, completeness of contracts, and pay-for-performance.

I also address the concept of rationality, as I think it is an important misconception of economics as a science to reduce "rationality" to a consistency condition of our preferences.

Next, I address the issue that money can in fact change our preferences undesiredly quite dramatically. Karl Marx named this ugly face of money the "fetish" [Mar67]. Due to its versatile nature, money is excellently suited as a reward, being an external stimulus that is supposed to reinforce otherwise spontaneously occurring behaviour. Consequentially it could potentially interfere with our autoregulation system that provides us with our autonomy in the sense of an addiction, generating non-free, or as I call them "tainted" preferences.

I conclude this chapter with a brief imagination of an alternative to today's combination of material flows and money cycles as the combination of material cycles and money flows. This would require to create distributed permanent sources and sinks for money.

With a concluding remark, I come to an end.

In summary, this book should give a picture of the meaning of money that is appropriate to its complexity. I would denote our time as the "semantic century", where we discover more and more phenomena where we have to take their context into account if we want to understand them appropriately. In this sense, money as a mechanism to support or to destroy our autonomy, the difference between public and private money, money expressing undisturbed or tainted preferences, money that works as recognition or as reward – are all functions of money whose realisations depend on its context of usage.

## Chapter 2

# Autonomous subjects interacting in a network of economic interactions

To understand the economic concept of money it is important not to jumpstart with game theory and utility considerations, but to understand the interaction aspects of a money based trade in detail. Thus, in this chapter, I start with delineating such a theory of interaction and how the current theory of economics is embedded therein.

For some reasons, economists like to talk about "agents" while denoting the economic subjects, perhaps to convey a more objective impression. I prefer to talk about "economic subjects", or just "subjects", to emphasize that I talk about autonomous people that are usually sufficiently economically competent and to contrast that notion with the notion of the objects that these subjects handle while being economically active.

Each subject is involved in many economic interactions, creating a huge interaction network. Fig. 2.1 shows a cutout of such a network of relevant economic interactions. In these kind of economic interaction network, none of the subjects is in total control of all the other subjects: the subjects' interactions don't, in general, determine the subjects' actions. In other words, the interactions are by and large nondeterministic, leaving room for each subject's decisions.

There are good and bad news about this network. The good news is: this network is open and, empirically, seems to scale almost indefinitely. This sheer scale draws our attention to the collective side of economic relations.

The bad news is: because of that, we will never be able to describe it completely. To describe it satisfactorily, we have to apply some tricks [Rei20a]. We first note that we can take two different perspectives. As I show in Fig. 2.2, we can focus our considerations on the interactions or on the participants. From an analytical point of view, both perspectives are based on different decoupling

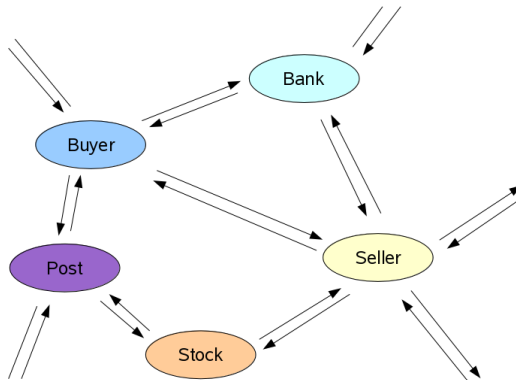


Figure 2.1: A cutout of an open network of economic interactions where the nodes represent the economic subjects in their roles relevant for a certain trade and the edges represent the interaction relations. A buyer interacts with a seller, payment is settled with the help of a bank, and delivery is done by a post via a stock.

cutout strategies, and from a constructive point of view, they are based on different composition classes of the same parts, the roles of the participants.

## 2.1 The interaction perspective

The interaction perspective cuts through the participating systems, or subjects, and relates to them not as a whole, but only as a projection onto the interactions, which I call a "role". I say that the subjects only play a "role" in the interaction. To my knowledge, such a role concept was originally advocated in the domain of sociology by Erving Goffman [Gof59]<sup>1</sup>.

It is worthwhile to look at these things in more technical detail to fully understand what we mean when we say that *"the subjects' interactions don't, in general, determine the subjects' actions. In other words, the interactions are by and large nondeterministic, leaving room for each participant's decisions."* Following [Rei20b, Rei20a] we will see how our comprehensive theory of interaction comprises the more traditional game theory which has become so important for economics.

### 2.1.1 System actions and interactions

I choose to use the theory of information, as developed mainly by Claude E. Shannon [Sha48, Sha49] as my starting point for our further considerations. It is

<sup>1</sup>Here my gratitude goes to Uta Gerhardt, in whose sociology seminar at the university of Gießen around 1990, I was able to become acquainted with Goffman's and her ideas about the role concept.

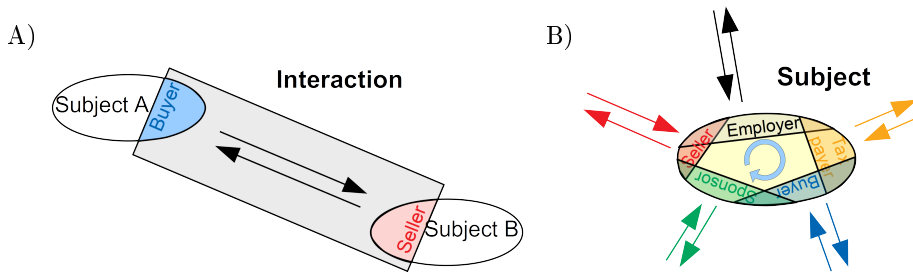


Figure 2.2: The two different perspectives on the open interaction networks, exemplified in Fig. 2.1. Part A represents the interaction perspective, focusing on the interaction between (two) subjects in their respective roles. Part B represents the system (or subject) perspective, focusing on the single system, coordinating all of its different roles, here a company being seller, employer, sponsor, tax payer and buyer all at once.

in fact a theory of system interaction and it obviously has been quite successful.

Claude E. Shannon proposed a new way to think about system interactions, namely to focus exclusively on the distinguishability of state values. Thereby he created "information" which can be transported *between* systems and processed *within* systems. A character in the sense of this theory is a unique name in the engineering language for a physical state value that can be distinguished from all the other state values this state can take in one system. The discrete set of all names of all distinguishable values of a system's state is called an "alphabet".

Thus, these characters only exist in our description of natural phenomena and their format is arbitrary – as long as they are pairwise distinct. But we need them, as without them, we could not talk about the phenomena of our consideration in our desired way. So, to talk about information in the sense of Claude E. Shannon's information theory means to talk about physical state values only in so far as we can distinguish them from other state values and disregard all their other aspects.

What can we do with information? We can process and we can transport them – that's all. Processing happens within systems and transporting between systems.

### Information processing: Systems

"To process" a character means to relate the state value it represents to some other distinguishable state value, again named with a unique character, *within* a single system by a function or a relation.

A system in this sense separates an inner state from the state of the rest of the world, the environment. A state in this sense is a time dependent function, taking a single out of a set of possible values, the alphabet  $A$ , at a given time [IECff]. I prefer to speak of "state function" and "state value". The key idea

is that these time-varying values are not independent, but some of them are uniquely related by an additional function: the system function. This system function thereby separates the state functions of a system from the state functions of the rest of the world. It also gives the system's state functions their input-, output-, or inner character. Such a relation logically implies causality and a time scale. The identification of this function is system-constitutive, which means that we are allowed to draw these nice little boxes so symbolize a system with its supposed "boundary" towards its environment only if we can provide (at least in principle) this relation.

Depending on the class of system function or time, different classes of systems can be identified. However, based in our information perspective, we will focus on discrete systems and time. I use  $\epsilon$  as the symbol for the empty character<sup>2</sup> in this formalism and for any alphabet  $A$  I define  $A^\epsilon = A \cup \{\epsilon\}$ .

Our description of the behaviour of our systems becomes simpler, if we drop the explicit time dependencies and use input/output transition systems (I/O-TSs) instead [Rei20a]. Another name in the literature for I/O-TS is "transducer" [Sak09], because this machine does nothing else than translating a stream of incoming characters into a stream of outgoing characters.

**Definition 1.** *An input/output transition system (I/O-TS)  $\mathcal{A}$  is given by the tuple  $\mathcal{A} = (I, O, Q, (q_0, o_0), \Delta)$  with  $I$  and  $O$  are the possibly empty input and output alphabets and  $Q$  is the non empty set of internal state values,  $(q_0, o_0)$  are the initial values of the internal state and output and  $\Delta_{\mathcal{A}} \subseteq I^\epsilon \times O^\epsilon \times Q \times Q$  is the transition relation describing the behaviour of a discrete system.*

If all sets are finite, the I/O-TS is called finite. Instead of writing  $(i, o, p, q) \in \Delta$ , I also write  $p \xrightarrow{i/o} q$ . A general execution fragment of an I/O-TS is a sequence of 3-tuples, listing the values that the input, output and state functions of the corresponding system have at the considered times:  $(i_0, o_0, p_0), (i_1, o_1, p_1), \dots, (i_n, o_n, p_n)$ . In the arrow notation, a single 3-tuple is written as  $\xrightarrow{i/o} p \xrightarrow{i'/o'}$ . Thus, in the arrow notation an execution fragment is written as  $\xrightarrow{i_0/o_0} p_0 \xrightarrow{i_1/o_1} p_1 \xrightarrow{i_2/o_2} \dots \xrightarrow{i_{n-1}/o_{n-1}} p_n \xrightarrow{i_n/o_n}$ .

The model provides each transition, that is, everything that can happen, with a context, the transition relation. In case that the transition relation is deterministic, it defines a partial function  $\delta : I \times Q \rightarrow O^\epsilon \times Q$  mapping pairs of input character and state value uniquely onto pairs of output character and new state value as  $(o, q) = \delta(i, p)$ . If the function is not partial but complete, because of the uniqueness-property of a function, we can be sure to have identified a system with all its states completely.

I also call a transition of a system in a deterministic context its "action". Thus, it's always the system as a whole that executes an action. Stating that "the

---

<sup>2</sup>The empty character can be understood as the neutral element of the concatenation operation such that for any given character  $i$ ,  $i \circ \epsilon = i$  holds. In the proposed formalism, the empty character as input means that there is no input and hence no possibility of a mapping. If a character has  $\epsilon$  only in some components, this means that these components are irrelevant for the processing of this character.



subjects' interactions don't, in general, determine the subjects' actions" then means that what a subject does is not entirely determined by the interaction context, but leaves room for decisions (see below).

The relevance of the context notion is obvious: a transition with a zero as input and zero as output which happens for example in the context of a deterministic transition relation representing the function  $f(x) = x$  has a different significance than the same transition, occurring in a deterministic transition relation representing the function  $f(x) = \sin(x)$ . To understand the significance of a transition in general or an action in particular, we not only have to know what happened, but we also have to have some knowledge about what would have happened, if some other input was provided or some other decision was taken.

In the case of nondeterminism, the input character and current state value do not determine the ensuing transition completely. This happens if spontaneous transitions exist with the empty character  $\epsilon$  as input or if there are, for a given state value, several outgoing transitions for a (true) input character. In this case – assuming guaranteed complete knowledge of a system only if we know its system function – we do not know the system completely.

### Information transport: Interaction

To talk about the "transport" of a character in the sense of Claude Shannon, we have to agree beforehand on a couple of additional things. First on a 1:1 fixed mapping of distinguishable state values in a first system, the "sender" system, onto distinguishable state values in a second system, the "receiver" system. Secondly, we document this agreement by identical naming of both alphabets in the frame of our informational description. And thirdly, by providing a mechanism that indeed provides this mapping physically.

Then, in our model, interaction simply means that information is transmitted and our description of interaction is based on the use of equal characters in the sending and receiving systems such that the state values of an output component of a transition of a "sender" system are reproduced in the input component of the "receiver" system and serve there as input of a further transition (see Fig. 2.3).

I name such a state function that serves as output as well as input of two systems a "Shannon state function". It is an idealized Shannon channel as it has no noise and no delays.

### 2.1.2 Protocols

In the following I focus on systems which interact with multiple other systems in a stateful and nondeterministic way. In the literature there have been many names coined for these kind of systems, some examples are "processes" (e.g. [MPW92]), "reactive systems" (e.g. [HP85]), "agents" (e.g. [Pos07]) or "interactive systems" (e.g. [Rei20a]). Their interactions are described by protocols [Hol91].

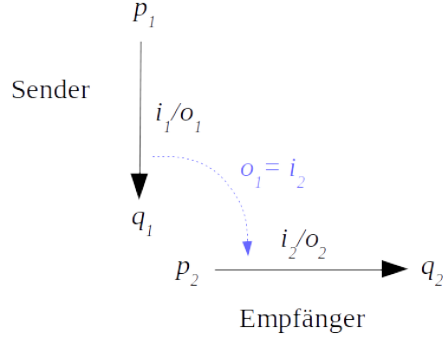


Figure 2.3: Interaction between two systems in which the output character of a "sender" system is used as the input character of a "receiver" system. Interaction therefore means the coupling of the two transition systems of sender and receiver based on the "exchanged" character.

While in deterministic interactions the result of an interaction is simply the composition to a super-system with a composed system function, in nondeterministic interactions, things are different. One important difference is that in this case, we need an additional criterion for success, the so-called acceptance component  $Acc$ . For finite calculations with a desired end, the acceptance component becomes  $Acc_{finite}$  and consists of the set of final state values. For infinite calculations of a finite automaton there are differently structured success criteria. One of them is the so-called Muller acceptance, where the acceptance component is a set of subsets of the state value set  $Q$ , i.e.  $Acc_{Muller} \subseteq \wp(Q)$ . An execution (see below) is considered to be Muller-successful whose finite set of infinitely often traversed state values is an element of this acceptance component (e.g. [Far01]).

We thus get from I/O-TS to I/O automata (I/O-A) by adding an additional acceptance component related to the success model to our transition system structure.

Given the I/O-As of all interacting systems of interest, such that all their input and output state functions represent Shannon states, their product I/O-A of the interaction is again an I/O-A and together with the set of Shannon states, it represents a protocol. Such a protocol is self-contained or closed in the sense, that it has neither any external inputs nor outputs any character.

**Definition 2.** A protocol is a pair  $(A, C)$  of a set of I/O-As, also called "roles"  $A = \mathcal{A}_1 \dots \mathcal{A}_n$  that represent the behaviour of  $n$  discrete systems and a set of coupling Shannon signals  $C$  that connect the output components with the input components, such that all inputs are provided by the output of one of the roles and no output goes somewhere else ("closure"-property)

A protocol can be interpreted as a set of rules within which an interaction can

be "executed". In the following, I define the execution of a protocol recursively. To simplify our further considerations, I assume all characters to have at most one component unequal the empty character  $\epsilon$ .

**Definition 3.** Let  $\mathcal{P}$  be a protocol with the roles  $\mathcal{A}_1 \dots \mathcal{A}_n$  that represent the behaviour of  $n$  discrete systems and the set  $C$  of coupling signals that connect the output components with the input components of the  $\mathcal{A}_i$ . There are no extra external input characters.

The current values of  $i$ ,  $o$  and  $q$  are indicated by a  $*$ , the values calculated in the current step by a  $+$ .

1. **Initialization (time  $j = 0$ ):**  $(q^*, o^*) = (q_0, o_0)_{\mathcal{P}}$ .
2. **Loop:** Determine for the current state  $q^*$  the set of all possible transitions. If this set is empty, end the calculation.
3. **Determine input character  $i^*$ :** Proceed in the following sequence:
  - (a) If the current output character  $o^* \in O_{\mathcal{P}}$  has the value  $v \neq \epsilon$  in its  $k$ -th component which I write symbolically as  $o^* = \epsilon[v, k]$ , and  $o^*$  is part of a feedback signal  $c = (k, l)$  to the input component  $0 \leq l \leq n$ , then set  $i^* = \epsilon[v, l]$ . If otherwise  $o^*$  is not part of a feedback signal, terminate the calculation with an error.
  - (b) Otherwise, if there are spontaneous transitions for  $q^*$ , select  $i^* = \epsilon$  as the current input character.
  - (c) otherwise finish the calculation.
4. **Transition:** With  $q^*$  as current state value and  $i^*$  as current input character select a transition  $t = (i^*, o^+, q^+, q^+) \in \Delta_{\mathcal{P}}$  and so determine  $o^+$  and  $q^+$ . If there is no possible transition at this point, terminate the calculation with an error.
5. **Repetition:** Set  $q^* = q^+$  and  $o^* = o^+$  and jump back to 2

With this execution rules, we see that the exchange of a character in our interaction model of protocols is indeed a bit more than just information transport, but it is a part of a coupling mechanism of system parts that restricts the reachable states of the resulting product automaton, the protocol.

We can write an execution fragment of a protocol  $\xrightarrow{o_0} p_0 \xrightarrow{i_0/o_1} p_1 \xrightarrow{i_1/o_2} \dots \xrightarrow{i_{n-1}/o_n} p_n \xrightarrow{i_n/}$  also as a sequence of pairs of state values and characters:  $(c_0, p_0) \rightarrow (c_1, p_1) \rightarrow \dots \rightarrow (c_n, p_n)$  where  $c_t = (i_t)_l = (o_t)_k$ .

I call an execution fragment which starts with an initial state and runs either until the acceptance condition is met or an execution error occurs a "run". And I call an execution fragment of a protocol that is started by the empty character and goes on until the output becomes empty an "interaction chain". Thus, with  $i \leq n$  and  $c_i = c_n = \epsilon$ , an interaction chain is characterized by  $p_i \rightarrow (c_{i+1}, p_{i+1}) \rightarrow \dots \rightarrow (c_{n-1}, p_{n-1}) \rightarrow p_n$ .

As can be seen from the error conditions in the execution rule, a protocol must fulfill certain consistency conditions to make sense. It has to be "well-formed" in the sense that for each transition with a sent character  $o$  unequal to  $\epsilon$  in at least one component, a corresponding receiving transition must exist. It must not contain infinite interaction chains, i.e. it must be "interruptible". And for each run, the acceptance condition has to be fulfilled. So, I define:

**Definition 4.** *A protocol is called ...*

1. ... "well formed" if each input character determined in step 2 can be processed in step 3.
2. ... "interruptible" if each interaction chain remains finite.
3. ... "accepting" if for each run the acceptance condition is fulfilled.

*A protocol that is well formed, interruptible, and accepting is called consistent.*

### 2.1.3 Games in interactive form (GIFs)

Protocols describe the interactions. Interestingly they are stateful and nondeterministic. If they were stateless and nondeterministic, they wouldn't make much sense, as stateless nondeterminism implies randomness. If they were deterministic, we would arrive at the case where interactions result only in the hierarchical composition of subsystems to supersystems and where we actually could eliminate any interactional aspects from our description [RS20].

Now, what is this nondeterminism good for? It opens up the possibility of introducing the concept of decision. For this we extend our behavioural model of a nondeterministic I/O-A with an additional input alphabet  $D$  such that the automaton with the input alphabet  $I' = D \times I$  becomes deterministic. I name the characters of this alphabet "decisions".

Decisions in this sense fill the latitude left open by the nondeterminism of the interaction and whose determination is hidden in the sense of "is not mentioned" by the underlying interaction description of a protocol. At this stage we can interpret decisions as a concept for us to uphold the fictitious notion of knowing a person "completely" in the sense that we can describe her as a system with a system function, despite the fact that we know her only by her role.

Decisions are very similar to information and can be seen as a further, "inner" input alphabet. They are enumerated by an alphabet and their names are relevant only for their distinction. In contrast to ordinary input characters, whose main characteristic is to appear in other output alphabets and that are allowed to appear in different transitions, we name all decisions of a corresponding transition system differently and different from all input and output characters and internal state values, so that we can be sure that they really do determine all transitions.

**Definition 5.** *Be  $\mathcal{A}$  an I/O-A and  $D$  an alphabet. The I/O-A  $\mathcal{A}'$  is called a "decision system" to  $\mathcal{A}$  and the elements of  $D$  "decisions", if  $I \cap D = \emptyset$ ,  $O \cap D = \emptyset$ ,*

$Q \cap D = \emptyset$ , and  $\Delta' \subseteq (I_A^\epsilon \times D) \times O_A^\epsilon \times Q_A \times Q_A$  with  $((i, d), o, p, q) \in \Delta'$  if  $(i, o, p, q) \in \Delta$  and for  $d$  applies:

$$d = \begin{cases} \epsilon, & \text{if there's no further transition } (i^*, o^*, p^*, q^*) \in \Delta \\ & \text{with } (i, p) = (i^*, p^*). \\ \text{so selected} & \text{that } \Delta' \text{ is deterministic, i.e. } \Delta' \text{ determines the function} \\ & f' : I^\epsilon \times D \times Q \rightarrow O^\epsilon \times Q \text{ with } (o, q) = f'(i, d, p). \\ & \text{For two transitions } t'_1, t'_2 \in \Delta' \text{ it holds } t'_1 \neq t'_2 \Rightarrow d_1 \neq d_2. \\ & \text{Additionally, } \Delta' \text{ is the smallest possible set.} \end{cases}$$

Obviously, the set of decisions for an already deterministic I/O-A is empty. I distinguish decisions from ordinary characters by a '@'-prefix and indicate that  $((@d, i), o, p, q) \in \Delta'$  also by writing  $p \xrightarrow{(@d, i)/o} q$ . In this sense, we can say that decisions determine the actions of a system from which we only know a nondeterministic transition relation.

With this conception we can define a fulfillment relation between a sequence of decisions and being "successful" in an interaction. Fulfillment relations are known from formal logic [EFT96] where a function is provided such that a certain relation holds. An example is an assignment function assigning values to the variables of a formal expression. Under some assignment the evaluation (or interpretation) of the formal expression results in either *true* or *false*. For example, the interpretation of the formal expression  $x + 5 = 9$  results in *true* for the assignment  $x = 4$  and *false* for the assignment  $x = 3$  or any other assignment.

We can now define a similar fulfillment relation between a sequence of decisions  $seq = d_1, d_2, \dots$  and the fulfillment of the protocol in the sense that we have to know the decisions to calculate a run of the underlying protocol.

**Definition 6.** Be  $\mathcal{P} = (R, C)$  a protocol with the roles  $R = \{\mathcal{R}_1, \dots, \mathcal{R}_n\}$ , interacting through the channels of set  $C$ . Each role is given by  $\mathcal{R}_i = (I, O, Q, (q_0, o_0), Acc, \Delta)_i$ . We say that a sequence of decisions  $seq = d_1, d_2, \dots$ , determining the actions of the roles in  $R$ , fulfills the protocol  $\mathcal{P}$ , written  $seq \models \mathcal{P}$  iff the acceptance condition of the protocol holds for the determined run according to the protocol execution 4 where we amend the Transition rule such that the selection choice becomes determined by the current decision.

For a consistent protocol, the acceptance condition holds for all possible sequences of decisions and I also write  $\models \mathcal{P}$ .

I call the decision automaton to a protocol, where every run is determined by a decision sequence also a "game in interactive form (GIF)". For technical interactions between machines, it is important that protocols are consistent. Interacting humans often put a lot of effort in reaching decisions either to make an interaction work or to impede it. Here, the fulfillment relation plays its strength if we view them as independent entities, where a GIF might realize a consistent protocol only if both player take the "right" decisions in certain situations.

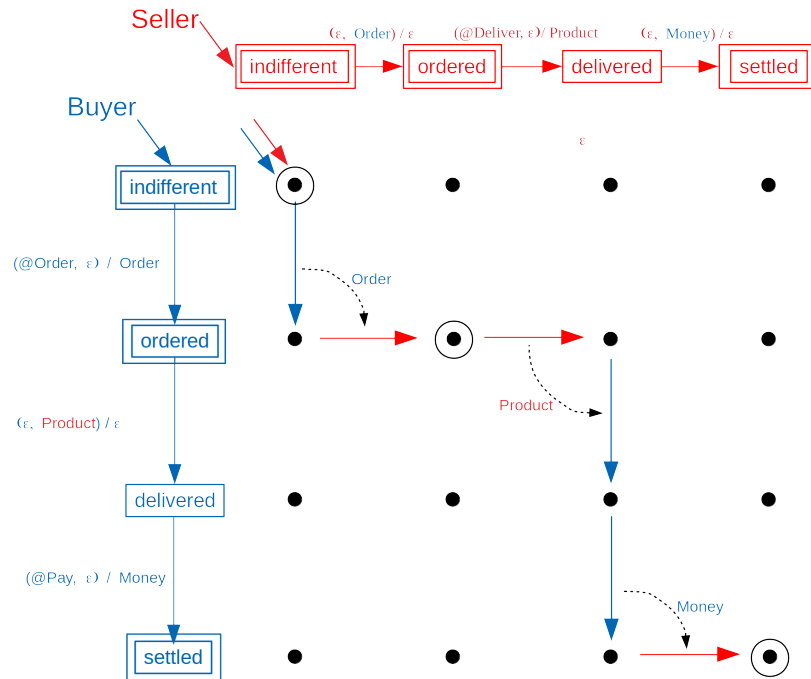


Figure 2.4: Two different systems, one in the role of a **seller** (red state chart) and one in the role of a **buyer** (blue state chart) interact by exchanging characters. **Buyer** indicates its interest in buying a good by sending an **Order**. If **seller** decides to sell its **Product**, he sends it to **buyer** such that **buyer** has to hand over the **money**. Possible final state values are marked with a double line. The coupling by character exchange is symbolised by a black quarter arc "connecting" two orthogonal transitions of **buyer** and **seller**. The character exchange mechanism obviously restricts the possible reachable state space of the product automaton.

In Fig 2.4, I illustrate this interaction model with a simple trade interaction between a **seller** and a **buyer**. I indicate both with different colors and talk about them as if **seller** and **buyer** were names. **buyer** decides **@Order** to buy something and indicates his transition into its new state value **ordered** to **seller** by sending her an **Order**-character. **seller** receives the **Order**, transits itself into her new state **ordered** and now contemplates about what to do. If **seller** decides **@Product** to sell the **Product**, she sends it to **buyer** who then has to decide **@Pay** to pay the bill and to send the **Money**. All state values which belong to the set of final states, where the interaction is allowed to stop, are marked by a double line.

If we focus on the decisions and take the character exchange only as a coupling mechanism which can otherwise be neglected, we reach at the automaton

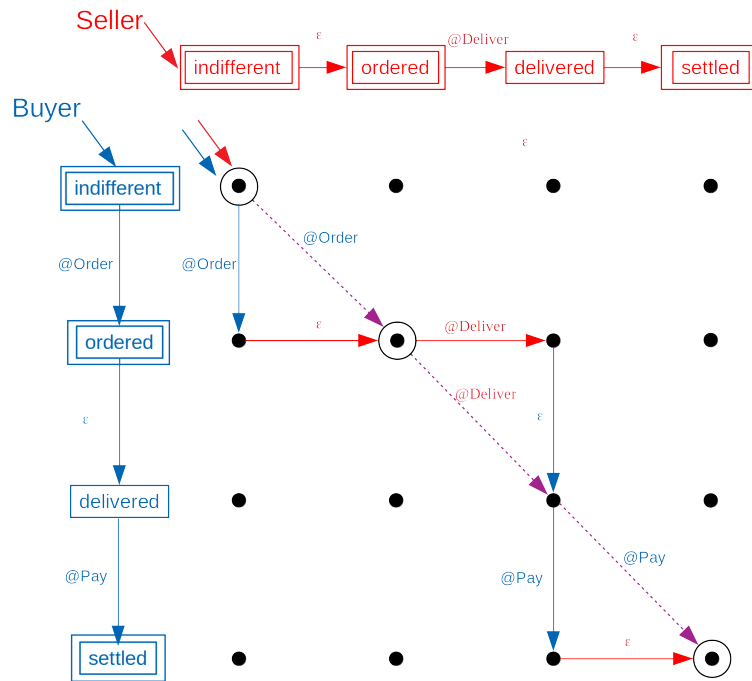


Figure 2.5: This diagram focus on the decisions taken by **buyer** and **seller** in the trade interaction as displayed in Fig. 2.4. **Buyer** initiates the interaction by taking the free decision *@Order*. It's free character is expressed by the fact that the whole interaction is allowed to end without this decision. **Seller** takes the free decision *@Deliver*. And finally, **buyer** takes the forced decision *@Pay*. Its forced character is expressed by the fact that the interaction is not allowed to stop without payment. Elimination of the transitions without any decision leads to the transition system of a game, drawn in purple.

of Fig. 2.5 which has only a single label at each transition, the decision. And if we further eliminate all  $\epsilon$ -transitions by abstraction where we define all transitions from a given state value and decision as equivalent which eventually lead to some target state without any further decision then we arrive at a game automaton, drawn in purple, which consists only of states and decisions. This  $\epsilon$ -elimination procedure is well known in automata theory [Sak09] and can always be performed while leaving the expressiveness of the automaton invariant.

So, we reach at the traditional structure of games by taking the interactional structure for granted and eliminate it. Then, it is suggestive as traditional game theory does, to direct the main focus to the question of the individual players' strategy (how to decide) in a single sort of game. But money-based trade is first and foremost an interaction, and by neglecting the "external" coupling mechanism of our roles, the *interaction*, we also neglect the other, "internal" coupling mechanism of our roles, what I name "*coordination*".

As I will show in the next section, what seems to be a decision in one interaction may just be a consequence of coordinating this interaction with another interaction. Even in single interactions, there may be decisions we have to take that are not free, but forced. In the example of Fig. 2.4, *buyer*'s decision to order was modelled as free, as *buyer* could take this decision or not – both cases were allowed. The same held for *seller*'s decision to deliver her product. However, *buyer*'s decision to pay was not free, but he was already bound by his decision to order and by the delivery of the product. So, he had to pay for it.

Interestingly, based on the two different classes of nondeterminism, we have two different classes of decisions: spontaneous decisions, eliciting otherwise spontaneous transitions and selection decisions which determine transitions where more than one transitions would accept a given input character. Every parents know the difference between asking their child: "Do you want to make your homework?" or "which homework are you going to do now?"

## 2.2 The subject perspective

Neglecting other interactions of the same subject is only an approximation. An important case, where this social isolation approximation becomes invalid, is, when our ability to coordinate multiple interactions is in the foreground.

The subject (or system) perspective cuts through the interactions and looks at the individual as a whole, ignoring all the relevant parts of the other subjects, connected somehow through interactions.

Taking the subject perspective while maintaining the role model of the interaction perspective requires us to look for an "inner" connection mechanism for the different role parts of a single subject in the sense of a "coordination": a subject coordinates its roles it takes in different interactions. We combine being father, husband, employee, son, uncle, buyer, seller, advisor, learner, learner etc. all in one individual.

With the whole subject in mind, one of the most important questions is, to what extend do additional interactions additionally determine our actions, or,



additionally create even more freedom? Do additional interactions extend or reduce our freedom of decisions?

What seems to be a decision in one interaction could be just a compelling consequence from another interaction. Forbidding a beggar to sleep under the bridge is different than banning a king.

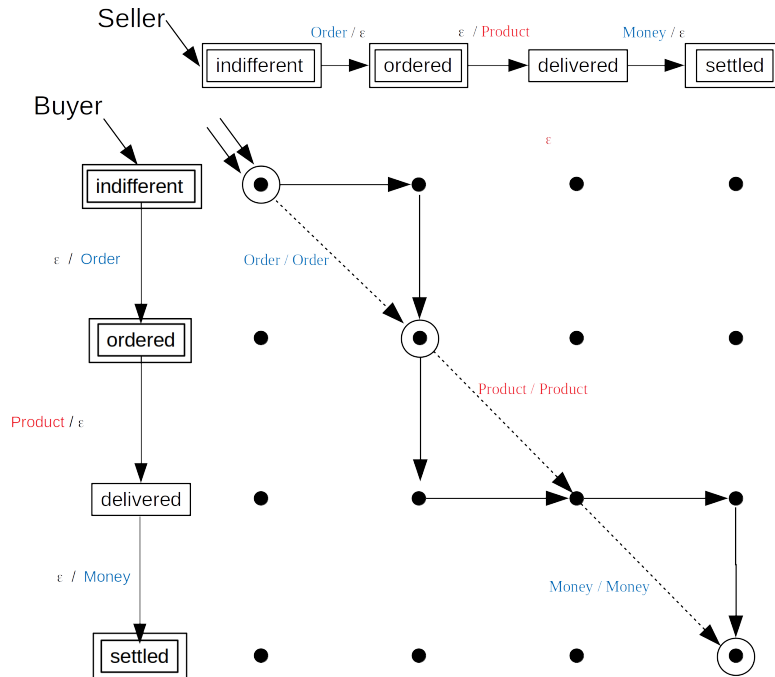


Figure 2.6: This diagram shows the state chart of a single system coordinating two roles of buyer and seller (therefore, both are coloured black). First it gets an *Order* from some buyer and passes it on to some other seller. From there it eventually gets back the *Product* which it passes back to the original buyer, who then sends the *Money*, which is again passed through to the other seller. Thus, the behaviour of this man-in-the-middle is fully determined by both interactions and their coordination. Like interaction, coordination also restricts the possible reachable state space of the product automaton of the involved roles, but by a different mechanism.

In Fig. 2.6, I illustrate "coordination", that is, the *internal* coupling of roles of the same subject, by coordinating the roles of *buyer* and *seller* such that an intermediary is generated. Coordinating roles means to restrict the product transition space by coordination rules. In the case of our intermediary, we have to get the *Order* of *seller* first to internally "hand it over" to *buyer* which sends it to some other subject in interacting as another seller. That is, the only initially allowed transition is the reception of the *Order* as *seller* and after that, the only

allowed transition is the one of **buyer** where it sent the *Order* away. If we next receive the *Product* as **buyer**, we again "hand it over" to **seller** to send it to the original buyer. And with the *Money* we eventually get, we do the same thing. All other transitions of the unrestricted product automaton are unreachable by this coordination.

In fact with the created man-in-the-middle, we effectively eliminated any nondeterminism and thereby any leeway for decisions. Thus, we can simplify this system by combining all "hand over" transition pairs to direct "diagonal" transitions as shown in Fig. 2.6 (dotted lines).

This example shows that we cannot ignore the dependencies that occur by coordination if we are interested in truly free decisions. I name a decision to be (truly) "free" if it is free for the subject as a whole, that is under coordination of all its roles.

For me, the possibility of truly free decisions, which I would take as a measure of people's autonomy, is absolutely essential for any economic theory I would like to pursue. This is a strong assumption and makes a strong tie between economics and ethics.

Do we have any proof for their existence? In my opinion the best proof is our social robustness in the sense of an extreme flexibility in adapting to variations of our social interactions, taking over new roles, abandoning old ones or modify existing roles virtually on the fly. If some of our interactions do start to determine our actions, the first thing we loose is our social coordination ability. Poverty is a good example, as Karl Marx accurately pointed out, writing: "*The realm of freedom begins, in fact, only when the work determined by necessity and external expediency comes to an end.*" [Mar94] (p. 828). Another one is drug addiction (see section 8.5) which is in my view essentially a disorder of our physiological apparatus to sustain our autonomy.

So, my thesis is that to understand the money mechanism, we have to consider both, interaction as well as coordination of a single subject. It seems to be at most trivial to say that money is at the heart of the social interaction between economic subjects to exchange commodities. But what seems to be rather overlooked is that the same holds equally true for the social coordination within a single individual. As we can spent every cent only once, it imposes a strict coordination constraint.

In this respect, money can support our social coordination ability very much and thereby increase our autonomy: we can use what we earn in one role in many other roles. But, by the very same function, money can also be a mean to destroy our freedom of decision and drive us into desolate slavery. So, to make our world a better place, it seems essential to understand which handling of money foster the economically desirable over the undesirable.

## Chapter 3

# How we decide

How do we as humans come to our decisions? How do we calculate them? Or should we better ask: do we calculate them? Is there any difference between selection and spontaneous decisions? Obviously, to answer this questions, we have to use a theory of our mind.

A seemingly obvious idea could be to try to figure out how we "calculate" our decisions in the sense of an algorithm. As games like chess illustrate, at least some part of our intelligence rests in the calculation aspect of our decision processes. But following this concept, we would face the methodological difficulty not to be able to observe the internal decision processes of people directly, we would run into all the complexities of the theory of computation, it would be clear from the beginning, that our "algorithms" would not have any physiological counterpart, as the brain is not a turing machine, and we would not capture the perhaps most important aspect, our drive or desire to act freely, to do what we want.

So, as a starter, is seems more promising to consider how we can provide "acting freely", that is not randomly but with a purpose, a simple, but clear meaning. To express this notion we have to provide a structure with which we can "explain" our decisions in this sense. The concept for this explanation of our free decisions is the rather simple concept of *preferences*.

If we are presented two alternatives for desert, like for example an apple and a peach, between which we eventually need to decide, we should be able to say which one we prefer more. And if this is the case we have all reason to assume that under totally unrestricted, that is under free circumstances, we would in any case decide for our more preferred dessert.

But we observe that people do not always decide to act in accordance to their preferences that we have discovered by some clever experiment. So why is that? Because its not only our preferences, i.e. what we want, that influence our decisions, but also our expectations or assumptions about the constraints the rest of the world imposes on us. Even if we discover that someone likes pears more than apples, this experiment had to create some expectation context for the proband. To discover his "true" preference, it was, for example, important that

both, pear and apple, were of top quality and as there are many different sorts of apples and pears, both had to be of that sort our proband liked most. But in our daily life, this context permanently changes. Perhaps our proband expects that, due to seasonal effects there are currently no tasty pears, or someone has warned her that someone else plans to poison her by a specially prepared pear, etc.

With our expectations and assumptions we anticipate the effects of our actions. Therefore, in our model, it are these assumptions about the world in which much of our intelligence becomes visible. To put it a bit differently, it is the subject's intelligence that necessitates us to include the subject's expectations about the results of its and others' actions into our behavioural model. The more intelligent people are, the more important context-effects probably become.

Often, we need to coordinate our different roles to act according to our preferences. For example, we prefer to have time with our family to do something enjoyable together over working, but we have to work to earn the money which gives us the necessary freedom. Or we prefer to buy a textbook on mathematics over visiting a restaurant with our friends because we are keen to learn complex analysis for next week's test and later on to become a great scientist. So, it is important to note that in the context of our preference relation isolating our different roles is only possible to a limited extent.

In summary, the preference concept explains different decisions of different people with identical expectations by different preferences and different decisions of the same person under different expectations by the expectations. Our theory of the mind is essentially a model of our ability to act as we want in an intelligent way, taking into account the rest of the world including in particular the possible choices and expectations of others.

I would say that this is a very positive way to think about ourselves and by no means is it somehow "orthogonal" or independent to any ethical concerns. If we as economists want to seriously apply this model to the world, we have to have a strong interest that its preconditions, first and foremost our freedom of economic choice, hold true "at all costs".

### 3.1 Preferences

Preferences, and also utility, are among the most fundamental concepts of modern economics (for a thorough introduction see for example [MCWG95]). The ability to define these concepts on an objective, that is mathematical basis paved the way for economics to become a science. The restricted language of mathematics with its sparse elementary vocabulary of elements, sets, relations, and functions allows us to gain an unequivocal understanding and to discuss the applicability and validity of these concepts in an intersubjective decisive way. To quote Leslie Lamport, one of my favorite Turing award winning contemporary computer scientist: "Mathematics is nature's way of letting you know how sloppy your writing is." [Lam02] (p.2)

Mathematically, speaking about preferences we say that we set the states of the world into a relation: Given two things of the world  $a$  and  $b$  we, for example, desire to possess, we may be able to say that we either prefer  $a$  over  $b$  or  $b$  over  $a$ , notated as  $a \succ b$  and  $b \succ a$ , or we may be indifferent between  $a$  and  $b$ , notated as  $a \sim b$ .

The elements of the set  $A$  are often called "alternatives", having for a start the two important mathematical properties, namely first to be pairwise distinguishable from all the other elements of the set, and secondly to be relateable by our preference relation. But one cannot avoid to also relate these alternatives to some real-world entities and here the consensus seems to diminish as some relate it to objects, some to states, some to decisions, others to actions or even to something else.

What are the entities of our behavioural model, we have to relate with preferences? Single state values? Which states? All of them? Looking at our interaction model, we see that relating the entities of the acceptance components by preferences would fit quite nicely as a true extension of our model. Instead of considering all acceptable outcomes as equivalent, the preference relation states that we prefer one outcome over the other.

One immediate consequence is that the entities our preference relate to are not just state values but depend on the computational model of the interaction. Interactions of finite length had as acceptance component a set of final state values, but the computational model of interactions of infinite length by finite I/O-Aa was more diverse and could be determined, for example, as Muller acceptance, the set of the finite set of all states which are repeated infinitely often.

We can now express our intuition about the behavioural relevance of our preferences in our model. If we observe one outcome  $a$  to be more likely than another one  $b$  in an interaction  $\mathcal{G}$ , despite both being equivalent from a protocol perspective, and assuming free decisions, then we can conclude the acting subject to prefer one outcome over the other in this setting.

**Definition 7.** *Be  $\mathcal{G} = (R, C)$  a GIF with the roles  $R = \{R_1, \dots, R_n\}$ . We say that a subject in role  $\mathcal{R}_i$  prefers an outcome  $a$  over an outcome  $b$  in  $\mathcal{G}$ , written as  $a \succeq_{\mathcal{G}} b$ , if it is more likely that it decides such that  $a$  is reached instead of  $b$ .*

This definition entails a couple of immediate conclusion. First, as preferences in this sense do not relate to every state in the world but just to outcomes in interactions, they may relate to some states or even to some sets of states. Thus, in this theory, it is improper to think of human behaviour to come about by taking every single decision considering the preferences of the immediately involved state values in the sense of a chain of transitions to successively more and more preferred states. But we may have complex chains of decisions taken to reach a single "final" state value or we may head for a desired state loop which we prefer over other state loops.

A second consequence is the context dependency of the preferences. What seems to be preferred looking exclusively at one interaction might just be a com-

elling consequence due to internal coordination constraints which only become obvious if we consider additional further interactions of the same subject.

Thirdly, as we can determine the preferences only by observing the results of the actions of a subject, and by our theory, the action-determining decisions of this subject are influenced by both, its preferences and by its assumptions and expectations, we may misinterpret some influence of its assumptions and expectations as being due to its preferences and vice versa.

And finally, with our theory we have created an intricate interplay between our and the subjects intentional behaviour. To sensibly talk about preferences, we first need to commit to the structure of the interaction. Here, we as the observer have to determine our intentions by designing the protocol with its set of a priori equivalent outcomes such that the observed can now express its intentions by choosing "freely" the one it prefers mostly.

I call a preference relation over a set of outcomes  $A$  to be "consistent" if it fulfills the two properties of completeness and transitivity defined in the usual way:

1. *Completeness*: for each two elements  $a, b$  of  $A$  it holds  $a \succsim b$  or  $b \succsim a$ .
2. *Transitivity*: for each  $a, b, c \in A$  it holds, if  $a \succsim b$  and  $b \succsim c$ , then also  $a \succsim c$ .

It is common in economics to name this property of the preference relation "rational". In section 8.4 I explain why I think that this is not a good idea to use this term, but "consistent" instead.

I delineate in the following why both properties are not necessarily fulfilled in everyday life.

### 3.1.1 Completeness

First, completeness. It might be possible to create laboratory situations, in which the number of outcomes is quite small and can be comprehended by normal subjects in their totality. But in real life, often, the interactions are not that clear and the number of possible outcomes are innumerable and may change on the fly. The real world just has far too many states.

Also, there is no need for completeness in the sense of any ability to prefer everything over everything else, like preferring such completely different things like getting the flu over spraining an ankle. There is nothing to decide — why should we care? There is no relevant action context where these two states would become relevant outcomes affecting some decisions.

Or something is a prerequisite of something other. For example, we prefer to live over being dead, and apples over bananas. Obviously to live is a prerequisite to prefer apples over bananas. So it is nonsense to ask us whether we prefer apples over to be alive. In this case, the hierarchy of reality directly structures our preferences hierarchically. The same may be true for outcomes of different interactions we are involved. Having some employment might be a prerequisite

to gain enough money to decide between apples and bananas. So it becomes nonsense to ask whether one prefers apples over having some employment.

And hierarchies within our preferences directly confines our freedom. As long as the preferences of the upper level are not taken into account, it doesn't make any sense to think about decisions according to our preferences of any lower level. That is, our assumption of freedom implies that the elements our preference relate to are somehow interchangeable. We could take the apple or we could take the banana. Although we prefer apples over bananas, we could live with either of them. Thus, as a free individual, we would perhaps usually opt for the apple, but under some special circumstances, we could also think of opting for the banana, perhaps because we know that a beloved one likes the apple even more than we do, or because it is cheaper and with the saved money, we can do something else. Thus, eating a banana is not a "no way" for us — which would express the hierarchical preference of being rather dead than eating a banana.

### 3.1.2 Transitivity

And transitivity is severely hampered, as for example A. Mas-Colell et al. [MCWG95] point out, by our limited ability to distinguish similar neural stimuli. Gustav T. Fechner [Fec60] discovered that for many sensory dimensions, the smallest change in stimuli that can be perceived — the "just-noticeable difference" — very often is proportional to the size of an ongoing stimulus. In marketing, this property of the human mind is of immediate relevance, as companies can try to hide negative changes to their products below the perception threshold or push positive changes to surpass this threshold (for example [Mon73]). Robin P. Cubitt, Daniel Navarro-Martinez and Chris Starmer give an overview on preference imprecision [CNMS15] and Oben K. Bayrak and John D. Hey provide a recent survey about the various concepts of preference imprecision [BH20].

As a result, the requirement of transitivity only makes sense with respect to human preferences, if our alphabet of alternatives really represents discernible, that is discrete entities for us. This is not the case for continuous alphabets like the real numbers. Does this mean that continuous alphabets are irrelevant to the human preferences context? In my opinion no. Often, it is easier to show some fundamental results for the continuous case. However, as with discrete mathematics versus mathematical analysis, we have to be careful in generalizing our results gained for the continuous to the discrete case.

### 3.1.3 Context dependencies: to reconcile multiple preferences

The completeness property implies that we are somehow able to state upon request our preference between every two outcomes of an interaction. This relation grows exponentially with the number of items. So for large sets of alternatives,

Garments	Preferences				
shoes	sneakers	$\gamma_{shoes}$	low shoes	$\gamma_{shoes}$	fine shoes
tops	shirt	$\gamma_{tops}$	T-shirt	$\gamma_{tops}$	shirt + jacket
trousers	woolen trousers	$\gamma_{trousers}$	jeans	$\gamma_{trousers}$	CORDS

Table 3.1: Assuming independent preferences for shoes, tops, and trousers.

even in case we were able to represent the preference relation internally, we would never be able to tell anyone.

One approach to deal with this is factorization, namely to assume that our preferences for different outcomes are independent. Let us look at an example where we assume that someone has consistent independent preferences for wearing different sorts of shoes, tops, and trousers. When asked, he states his preferences according to Tab. 3.1.

Looking at this table, one would guess that he would wear a woolen trouser, a shirt and sneakers all the time. In fact, you will never see him dressed that way. Why? Because his preferences of garments are not independent, but context dependent. According to our theory, preferences become relevant only with respect to outcomes of interactions which happens in the context of all involved subjects and their embeddedness in the rest of the world. Developing preferences only within given contexts has the great advantage that the number of different contexts is relatively small compared to the number of states of the world and it fits nicely to the fact, that for our decisions to become meaningful requires some context notion anyway. [Rei20b].

Our proband has quite clear ideas which garments fit each other for which occasion. He will either wear  $A = \{\text{sneakers, jeans, T-shirt}\}$  or  $B = \{\text{low shoes, cords, shirt}\}$  or  $C = \{\text{fine shoes, woolen trousers, shirt + jacket}\}$  and makes his decision context-related. In his leisure time, he will prefer  $A$  most, at work it is  $B$  and at celebrations, it is  $C$ . His complete preference of the garment combinations is shown in Tab. 3.2.

So, context-dependencies is a very plausible way to avoid the combinatorial explosion of preference. Actually it shows that the problem of combinatorial explosion just does not exist in reality. It is artificially created by the request to have a complete preference relation over everything. In reality, there is no need to have a firm opinion on whether we prefer sneakers over low shoes over fine shoes as such, independently from any other things we might ponder about. In reality we only have to know how to dress in a given social context, we only have to have preferences where they may influence relevant decisions. In my experience, people react quite irritated if they are confronted with "alternatives" they cannot assign to a common action context.

But now, let us assume that our proband is nevertheless asked by his 9 year old daughter which shoes he prefers mostly and he — for whatever reason, probably because she insists — valuating this as a sensible question, tries to figure out his preferences on this issue by aggregating his so far existing context



Context	Preferences				
leisure time	A	$\succ_{leisure}$	B	$\succ_{leisure}$	C
work	B	$\succ_{work}$	C	$\succ_{work}$	A
celebration	C	$\succ_{celebr}$	A	$\succ_{celebr}$	B

Table 3.2: A possible context dependent preference relation on bundles of different garments of someone, where  $A = \{\text{sneakers, jeans, T-shirt}\}$ ,  $B = \{\text{low shoes, cords, shirt}\}$  and  $C = \{\text{fine shoes, woolen trousers, shirt + jacket}\}$ , leading to circular aggregated preferences on the different bundles.

dependent preferences. That is, we are now talking about some procedure to calculate preferences we are asked for based on preferences we already have.

During both, leisure time and celebration, he prefers sneakers being a part of  $A$  over low shoes being a part of  $B$ . During leisure time and work, he prefers low shoes being part of  $B$  over fine shoes being a part of  $C$  and during work and celebration, he prefers fine shoes being a part of  $C$  over sneakers being a part of  $A$ . In other words: assuming no hierarchical preference between leisure time, work and celebration, he discovers himself having circular preferences for shoes, as well as all other garments.

This seemingly paradox, that sensible aggregation methods of transitive preferences may lead to intransitive 'collective' preferences, is well known in voting theory as "Condorcet's paradox"[JANdCC85]. Surprisingly, as I have shown, this can be relevant also in every individual bundling their objects of preference according to some context. Also, as we know from Arrows Theorem of voting [Arr51], there is no optimal aggregation method for aggregating ranked preferences of individuals to a collective preference. Hence, different aggregation methods with different positive and negative properties may result in different aggregation results. And we do not know whether any biologically implemented aggregation is constant in this sense. Thus, another mechanism to induce inconsistent preference could be introduced by varying aggregation procedures of context dependent preferences.

Additionally, we may have to decide between alternatives where our preference depends on additional future events. This problem is named "induced preferences". For example, we may sit in a restaurant and have to decide between red and white wine before we know the menu card (example from [MCWG95]). Or we have to decide the form of school without knowing our future profession. These kind of dependencies also result in an exponential increase in the number of the to-be-considered alternatives and thereby in a complexity problem.

One could object that, from a "theoretical" perspective, one could always redefine the notion of a commodity to include the context, say an umbrella in a sunny day is a different commodity from an umbrella in a rainy day. Proceeding this way, we could eliminate context driven inconsistencies but would again run into the exponential blowup problem. Acutally, the whole realm of modern cryptography rests on the important distinction between the theoretically pos-

sible and the practically realizable [KL15]: although it is theoretically possible to check out  $2^n$  (with large  $n$ ) possibilities, it is practically impossible because of our limited resources. And nobody disputes the relevance of cryptographic security, just because it is "theoretically" possible break it up.

So, inconsistent preferences in the sense that they are incomplete or intransitive seem to be not the exception, but the rule (see also [Fis91]). It is highly likely that we internally do some "preference calculation" which might be an additional source of variance. Actually, intransitive preferences due to preference aggregation are well known in economics. Kenneth O May [May54] reports evidence for intransitive preferences stemming from the necessity of aggregating over conflicting multi-dimensional preferences. One of his examples is an experiment where 62 college students had to choose between three hypothetical marriage partners,  $x$ ,  $y$ , and  $z$  that ranked differently in the three dimensions of intelligence ( $xyz$ ), looks ( $yzx$ ), and in wealth ( $zxy$ ). Under the particular testing conditions, 17 students showed a circular preference pattern ( $xyzx$ ).

This fact does not devalue the concept of preferences, it just puts it into the right perspective. The world is just too complex to comprehend it in a completely consistent manner — and we are well advised to shape it in a way that it forgives us some inconsistency in our preferences here and there.

## 3.2 Utility

Under certain circumstances we can significantly simplify our considerations about preferences by introducing something economists call "utility". The idea is to define a function  $util : A \rightarrow \mathbb{R}$ , mapping the set of alternatives of our preferences to the domain of real numbers, the "utility", and say that this function represents our preference relation  $\succsim$ , if  $util(a) \geq util(b)$  is equivalent to  $a \succsim b$ . We thereby reduce a property of a binary relation between two things to a property, the utility, that can be attribute to a single thing.

There are a number of propositions describing under which conditions it is possible to represent preference relations with utility functions. The preference relation has to be at least consistent, that is, transitive and complete. Then, in the countable case with a fixed preference relation, there always exists a representing utility function. However, for preference relations over subsets of the real numbers this is not always the case. One important case, where we can provide a corresponding utility function, was proven by Gérard Debreu [Deb54], namely for continuous preference relations over convex domains.

In fact, a utility function over-specifies its corresponding preference relation. If one such utility function  $f$  exists, then any concatenation  $u \circ f$  with a strong monotone function  $u : \mathbb{R} \rightarrow \mathbb{R}$  is also a corresponding utility function to the same preference relation — and none of these functions is somehow marked.

Please note that beside the issue of over-specification, talking about utility (where this is allowed per assumption) is really the same as talking about preferences. "utility maximization" then just means to realize what you prefer most. Thus, the traditional equation of "utility maximization" with egoism, in

the sense of having preference that are directed only towards oneself, is – independent on how deep this tradition is rooted in economics – nonsense, as the utility concept does not determine the content of the preferences it is supposed to express. For example, I can prefer the state of the world where my neighbour feels well over that where he feels bad and express the same fact by a utility function, as long as all the preconditions for a utility representation are fulfilled.

Also, the thesis that there is only egoism anyway, since every other social reference has to be expressed by utility in the sense of "self-interest" is just another disguise of the improper equation of egoism and utility maximisation. In section 8.3 I discuss the relevance of the model of the economic egoist in a bit more detail. Here it should suffice that egoism is not entailed in the model of utility maximization but represents an additional genuine assumption on its own.

If the alternatives occur no longer with certainty, but with uncertainty, then the model has to be extended. Johann von Neumann and Oskar Morgenstern [vNM44] axiomatized an approach where they looked not at certain outcomes but at probability distributions over outcomes, named them "lotteries", and viewed these lotteries as the to-be-preferred alternatives.

The existence of a von-Neumann-Morgenstern (vNM) utility function, attributing a utility to every lottery, additionally requires a continuity of the corresponding preference relation in the sense that for each lottery  $l$  which is encased between two other lotteries  $l_l$  and  $l_h$  as  $l_l \succ l \succ l_h$ , there is always a lottery  $l'$  lying on the straight line between  $l_l$  and  $l_h$  with  $l \sim l'$ .

If beyond continuity, the preferences over two lotteries is independent on any additional mixed-in third lottery, then there exists a so called "expected utility function" which is linear in the probabilities. Then, the utility-value is the expectation value of the utility distribution.

As with ordinary utility, if a suitable vNM-utility representation of a preference relation exists, then there are infinitely many others that are also suitable. However, whereas ordinary utility is an ordinal function, where a twofold utility value does not mean "two times as much utility", this property holds for the expected utility as it is cardinal. Hence, expected utility is preserved only by linear transformations.

### 3.2.1 Preferences that cannot be represented as utility

As said in the beginning of the last section, inconsistent preferences cannot be represented by utility functions. This is very important, as it implies, conversely that using utility functions, we render ourselves blind against inconsistencies in our preferences.

Another important case, where we demonstrably cannot represent a preference relation by a utility function on the domain of real numbers are hierarchical preferences, also called "lexicographic" preferences, where substitutability is strictly limited to separable realms. Thus, the essential property of the alternatives of the different levels of a hierarchical preference relation is their non-exchangeability in the preference context. An example is a dying man of thirst

who will prefer any amount of water before he will even consider something to eat.

Economic consideration about hierarchical preferences can be traced back well into the 19th century [Eng95]. In his review, Stavros A. Drakopoulos [Dra94] provides some implications for economic analysis. Meanwhile, there is clear empirical evidence for a preference hierarchy between, for example, staple food and other goods [CM12].

Lexicographic preferences also do not fulfill the vNM-condition. For example, the preference of the alternative to gain 0€ is surely enclosed by the preference to die and to get 10€. However, there is no lottery with respect to the latter two alternatives to die or to get 10€, which we were indifferent compared to getting 0€. Again, this continuity somehow implies exchangeability.

But the impossibility of representing hierarchical preferences is not restricted to the continuous case. It also concerns the discrete case if the preference relation is not fixed once and for all but is calculated in an ongoing way over the items we prefer. Then we cannot provide a priori a fixed number that marks the hierarchy transition and thus we cannot represent the hierarchical utility in a single natural number.

Another source of "inconsistency" is the differing approach of people towards chances and risks, as was indicated by Maurice Allais [All53] in 1953 and which invalidates the independence axiom of vNM. If we can realize most of our dreams and desires with securely receiving 500.000€ — why should we jeopardize this security for a chance to get a much larger sum together with a small risk of a complete loss? We only live once and as such, randomness decomposes into risk and chance. It's a relevant difference to be in a situation any number of times and thereby realizing some expectation value or just once — otherwise there wouldn't be any business model for insurances.

Furthermore, Daniel Ellsberg [Ell61] pointed out in 1961 that people frequently, even on reflection, decide between uncertain alternatives in a way that we cannot interfere any meaningful probability assumptions (for a recent overview on these kind of ambiguities see [MS14]). This fits to the fact, that most of the uncertainties we have to deal with come in the form of unknowingness and cannot be measured in the sense of a probability. Thus, compensating this unknowingness with an assumed probability distribution becomes just one out of many possible heuristics.

### 3.2.2 Utility that cannot be maximized

Even if all assumptions to justify a utility-representation of some of our preferences hold, we may not be able to determine its maximum, neither from an objective or analytical, nor from an intuitive perspective.

First, optimization is a costly business in itself, starting with the transactional costs to gather the necessary information, not to mention our limited computational capacity. As any utility function is exactly that, a function, we have all the issues of computability and efficiency for its constructive calculation known from theoretical informatics.

In his nobel price lecture, Herbert S. Simon [Sim78] formulated: *"rationality is bounded when it falls short of omniscience. And the failures of omniscience are largely failures of knowing all the alternatives, uncertainty about relevant exogenous events, and inability to calculate consequences."* From this perspective, most trials to determine our behaviour in real life situations by utility optimization are doomed to failure as they would completely block us from doing anything and 'good enough' becomes the guiding principle,

Beyond that, two additional quite practical and often rather overlooked issues hinder us to determine our usual behaviour by utility maximization [Rei16]. The first one is the high number of dimensions of our usual preference space. Just think that you want to buy a mobile. Now you must choose one out of the many available types. Just imagine in how many respects mobiles could differ: weight, size, age, manufacturer, number and kind and quality of sensors and actors, security, robustness, reliability, extensability, maintainability, availability, price, performance, testability, usability, manufacturability, recyclability, etc. This list is not exhaustive. On the contrary, each dimension, or 'quality' as they are also called, can be further subdivided into many subdivisions. The number of relevant parameters to characterize a mobile to which our preference can relate to goes into the hundreds. An overview on different quality models and their number of qualities to be distinguished provide [BBK<sup>+</sup>78, MRW77, ISO11]

Now we are hit by what Richard E. Bellman [Bel61] succinctly called the *"curse of dimensionality"*, the cumbersome, non-intuitive aspects of high-dimensionality. For example, with increasing dimensions, the volume of a unit-sphere, representing somehow 'similarity' as proximity, shrinks quickly to zero, meaning that most of the volume of a unit-cube becomes distributed "in the edges". Kevin Beyer, Jonathan Goldstein, Raghu Ramakrishnan, and Uri Shaft [BGRS99] showed that under a broad set of conditions, as dimensionality increases, distance measures lose their significance, as in a large class of distributions the distance to the nearest data point  $dist_{min}$  approaches the distance to the farthest  $dist_{max}$ , or symbolically  $\lim_{n \rightarrow \infty} \frac{dist_{max}}{dist_{min}} = 1$

As a result, adding more and more dimensions does not necessarily help us in differentiating which mobile we desire most, but quite often does the opposite: the contrast diminishes. A simple heuristic that I describe in [Rei16] is to hierarchically classify qualities into (few) key qualities and (many - the rest) necessary qualities, depending on the expected context of usage. Key qualities create contrast and positively distinguish a product. I prefer my mobile because it has such an awesome display, a super camera and a durable battery. Necessary qualities usually diminish contrast and therefore distinguish a product only if they are too negative. Although I will telephone a lot with my mobile, speech quality is perhaps only relevant for me if it is too bad. And so are all the other necessary qualities. One could interpret Rosser Reeves' *"Unique selling proposition"* [Ree61] as relating to such key qualities. He characterized a unique selling proposition as a proposition which convinces the potential customer by pointing to a specific benefit and which the competition cannot or does not offer.

The second issue is construct validity. It is consensus in the engineering

sciences that measuring a quality requires determination of the context of usage for the system under consideration. And this context dependency leads to an inherent conflict between the validity and applicability of our quality measure. The narrower we make our context specification, the more valid the quality measure becomes for this special context – but the less applicable it will be for other contexts. One could name it the *“semantic uncertainty relation”*. As a result, quality notions which are supposed to be valid in a very broad context, like “being successful” are hardly measurable at all.

Cem Kaner and Walter P. Bond [KB04] provide an excellent discussion of the topic of construct validity with two in depth examples of “Mean Time to Failure (MTTF)” and “bug count”. They show that even these simple measures are by no means “direct” or “base”, but depend in their meaningfulness on many additional contextual assumptions.

### 3.2.3 Interpersonal comparison of preference and utility

As preferences are entirely subjective, an essential question in our conceptual framework is: How can we relate the different preferences or utilities of different people?

In fact, in the middle of the 20th century, based on the understanding that the choice of any particular utility function out of the many possible to represent a preference relation is arbitrary, it was mainstream to think that interpersonal comparison of utility was “unscientific”. To quote some well known scholars of that time: Lionel Robbins ([Rob38], said *“every mind is inscrutable to every other mind and no common denominator of feeling is possible”*. This conviction seemed to be the base why he thought that the relation between ethics [viewed as “speculative”] and economics [viewed as “scientific”] could only be a “mere juxtaposition” [Rob32] (p.132). Kenneth Arrow [Arr51] still said that *“interpersonal comparison of utilities has no meaning.”*

According to his own account, Amartya Sen [Sen08] was *“much concerned with incorporating different ways of making interpersonal comparisons and their far-reaching consequences on what is permissible in welfare economics.”*, culminating in his book “Collective Choice and Social Welfare” in 1970 [Sen70]. But even Amartya Sen denied in 1999 [Sen99] (p.68) that it makes sense to interpersonally compare utility.

To me this seems really strange. If we as economists want to say anything sensible about the distribution of scarce goods, fundamentally based on the preferences of the people — how could we achieve that without relating the preferences of these people to one another? Obviously, in the 20th century it was obviously not necessary to agree on one of the most fundamental problems of this science to become a great economist.

And in sharp contrast to this dismissive attitude, it is well known that utility, under well defined circumstances could even be “transferred” from one person to another. This property is the base for game theorists like Roger B. Myerson to classify cooperative games into those with and those without transferable

utility [Mye91] (pp. 384). The base for this transferability is the representation of utility in a special form, namely as a linear function.

It is perhaps the major contribution of this book to explain under what conditions money can provide a somehow "magic" mechanism which makes our entirely subjective preference relations intersubjectively comparable and utility indeed transferable. The key is to take advantage of the infinite many ways to represent our (consistent) preferences with a utility function to choose just the single one which has the desired properties. It suffices to have a single possible valid utility function to be capable of talking about utility and still meaning our preferences.

### 3.3 Beyond the preference concept

With the preference concept we introduced a binary relation about all sorts of things and assumed that we will take any economically relevant decision according to this relation within the framework of our additional assumptions about the constraints of our environment. We did not try to explain *why* people prefer one thing over others. To address this issue as well, we would need to give more structure to our theory of mind.

The immediate first question is: do we need to do that as economists? My answer is a clear yes. We cannot delegate the question of how our preferences are formed to other scientific disciplines, like psychology, for several reasons, some of which I list in the following.

First of all, two central, empirically testable conclusions of our money model state how money does or does not influence our preferences (see Eq. 4.12 and 4.13). If money works according to our model, it will always be preferable to have more than less money and money will not influence our other preferences.

Secondly, any restriction to a certain level of explanation seems to be artificial. Why should an economist not ask the obviously economically relevant question: How do we know what we want? Is it always clear? Just ask adolescents about their career aspirations. Often, people are ambivalent and not coherent about their preferences, meaning that they have simultaneously positive as well as negative, conflicting valuations towards some object.

Even our thinking is not a homogenous whole, but results from the cooperation of different, physiologically identifiable subsystems. An early such model was that of Sigmund Freud [Fre23] structuring our mind in id, ego and super-ego. A more recent model was proposed by Daniel Kahnemann [Kah11] who distinguished two complementing systems of thinking. One implements a fast and more instinctive mode and the other one implements a slower, more considering, logical mode of thinking.

How do we know that we are free in any particular decision we take? As the phenomena of addiction and compulsive disorders shows, just having seemingly strong preferences does not imply that we are free to decide. I therefore think it necessary to distinguish between "free" preferences as the basis of "free" decisions of an autonomously acting subject and "tainted" preferences, still being the base

of decisions according to our concept, but no longer the base for its autonomy. Thus, it's not enough to postulate that we have preferences on outcomes and the ability to decide freely, that is, according to these preferences. But, considering the empirical evidence that there can be more or less such freedom, our economic theory with its understanding of our freedom is incomplete at its very base as long as we do not understand how our preferences are determined.

Thirdly and trivially, essential economic issues may depend to some extent on the content of the people's preferences. The social preferences of different people might differ pretty much. People who prefer to do nothing rather than something are likely to be worse off economically in the long run, etc.

Economists talk a lot about "rational behaviour", but an essential pillar of the whole advertising industry is the influence of our emotions on our purchasing decisions. So, what about the relation between understanding and emotion? I will comment in section 8.4 on that relation a little more detailed.

And taking preferences as given and ignoring how they are built we would also ignore a perhaps existing, quite positive influence of our economic activities on our mind. I think it highly likely that there is not only an influence of our preferences on our economically relevant decisions, but also a relevant effect in the opposite direction, in which a highly differentiated economic environment supports us in developing sufficiently consistent preferences over material commodities that hamper the possibilities of a possible economic exploitation. In this respect, sufficiently consistent material preferences might be, to some extent, a cultural achievement.

### 3.3.1 Intentions: the difference between spontaneous and selection decisions

As last limitation of the preference concept I would like to address is the classification of decisions into spontaneous and selection decisions. For a selection decision in an interaction, I always have an additional input triggering a decision between several alternatives. I can empirically measure my preference between an apple and a pear and then observe which one I will buy in a defined situation, for example, where I already decided to buy some fruits, standing in front of the fruit counter in the supermarket and choose one over the other depending on their respective prices.

In a spontaneous decision, however, there is no new information available, not even in the sense of a simple trigger signal. We just take it like that. The alternative to a spontaneous decision is to remain in the status quo, that is, to do nothing. The question here is: Why should I buy any fruit at all? Why do I transit from being indifferent to some meaningful state? Thus, it seems to me that it is not so easy to determine our preference relation with respect to spontaneous decisions then it is with respect to selection decisions. To keep this difference in mind, I name the preferences, that are the base for spontaneous decisions also "intentions": we act spontaneously to fulfill our intentions.

But we have to be careful. One important reason for seemingly spontaneous decisions in some interaction roles are in fact actions with some input in another



interaction, established by internal coordination. But then they are not truly spontaneous and we do not express our true intentions with them. What we are interested in are the truly spontaneous decisions. Here, I think, our creativity shows up.

It seems to me that the too exclusive focus on the class of selection decisions in economics has had serious consequences. It conceptually ignored the true intentions of the acting subjects, or replaced them by the simple desire to gather richness, and also positioned a concept of a manager as a "decision maker". In management reality, the alternatives are often prepared in advance to be of similar value and the number of alternatives to be quite manageable. So well prepared, the fact that a manager decides at all often becomes more important than the actual decision itself, especially in an economic context, where the exchangeability of the alternatives is a prerequisite. And in modern organisations, truly important selection decisions are usually not made by single individuals, but by groups of people like a board. The much more difficult situations are when we have a combination of spontaneous and selection decisions with an incalculable number of alternatives. For a manager this is the situation when she decides about which alternatives should be prepared for a future selection decision.

### 3.4 Summary

In modern economics, perhaps the most prominent example for overstressing the arc was based on using the utility concept beyond its domain of validity, known as "rational choice theory". It stated that "all human behaviour can be viewed as involving participants who maximize their utility from a stable set of preferences and accumulate a maximal amount of information and other inputs in a variety of markets.", as Gary Becker [Bec76] formulated it in 1976. In 1996 he extended the utility-maximizing approach to include endogenous preferences [Bec96]. Other prominent representatives had been Michael C. Jensen and William H. Meckling [JM76, JM94].

As we have seen, preferences is the more general concept contemporary economics is build upon. We can use the utility concept only under very narrowly defined circumstances to simplify our preference considerations. There are many preferences that cannot, under no circumstances, be represented as utility at all. And even if we are allowed to use the utility concept, there are a couple of important and relevant reasons which may effectively hinder us to determine any real maximum to guide our behaviour. And if we do act to maximize our utility, we just do what we prefer most, which need not be selfish or egoistic as it is often assumed.

So, utility is nothing we have to look for in the brains of creatures. Also, there is not the "one and only" utility. But — at least in economics — utility is just a concept to simplify certain preference-related considerations. Its validity depends on clearly expressible preconditions, like consistency or some sort of exchangeability. If we talk about utility, we always have to keep these precondi-

tions in mind to assure that we still talk about preferences. Otherwise we risk to talk about something we still name "utility" but which is not related any more to the preference of people.

Perhaps I sound rather negative with all this emphasise I put on the restrictions imposed on the realm of valid utility representations. In fact, the opposite is true. Why that? Why is the utility concept so central to economics despite all its obvious limitations? Because it helps us to clear up the miracle how money works – or as I should say: could work, how we could use money to objectively compare certain subjective preferences of different people and therewith create a social coordination mechanism to fairly express our free material preferences. And understanding this function of money requires us to understand that money cannot, by construction, express all of our preferences, but, in the best case, only those that can be represented by a utility function and in the worst case not even those. In the next section, I will elaborate on this idea.

## Chapter 4

# Money as a mechanism to intersubjectively express material preferences and to transfer utility

Equipped with a clear understanding of utility, I can now state more precisely, what I mean by saying that money should be a mechanism to distribute utility. After some brief historic considerations, I will describe money as a social mechanism by applying the introduced two perspectives to the trade interactions and the acting subjects in their seller and buyer roles. And secondly, as the validity of the utility concept, in the sense that it reflects our preferences, is bound to several requirements, I will investigate the circumstances under which these requirements are fulfilled.

### 4.1 Brief historic consideration

History shows us that the understanding of money as a social mechanism evolved during history and builds on a couple of different concepts, one of which was utility as I presented it in the last section.

Another concept is that of economic value. Fascinatingly, we can trace its discussion back at least to the ancient Greek philosophers. In his dialogue Euthydemus, Platon let his character Sokrates say ([Pla67], p. 304):

*”For it is the rare, Euthydemus, that is precious, while water is cheapest, though best, as Pindar said.”*

Thereby Platon indicates that even others, like Pindar, had thought this issue thoroughly through and came to some not totally obvious but convincing conclusion.

Aristoteles already distinguished ([Ari12], chapter 9) two different types of usage of every possession, one natural one and another one of exchange. The natural way of usage is limited, the usage of exchange is unlimited. He says *"Thus in the art of acquiring riches there are no limits, for the object of that is money and possessions"*. Aristoteles thinks that most money can be accumulated by trade but he does not commit himself to whether wealth does consist in the amount of money one has or not (like Midas). He detests lending against interest as being unnatural, *"as it is increasing our fortune by money itself, and not employing it for the purpose it was originally intended, namely exchange."*

In his Nicomachean Ethics [Ari09], Aristoteles focus very much on the right ethical attitude or "virtue" towards the usage of money. However, in Book V, section "Justice in exchange, reciprocity", he describes several functions of money.

- (p.89) Measurement and Medium of Exchange: *"All things that are exchanged must be somehow comparable. It is for this end that money has been introduced, and it becomes in a sense an intermediate; for it measures all things, and therefore the excess and the defect — how many shoes are equal to a house or to a given amount of food."*
- (p.89) Store of value: money change its worth as goods do, but *"it tends to be steadier"*.
- (p.89) Provision of ubiquitous supply: *"it must be possible for us to get what we want by bringing the money"*

Additionally, he analyses the money based bargain:

- (p.88) An equal bargain requires *"proportionate equality of goods"*.
- (p.89) The exchange of a bargain is driven by the needs of buyer and seller, which are set to equal in the transaction. (also p.90) *"Now in truth it is impossible that things differing so much should become commensurate, but with reference to need they may become so sufficiently."*
- (p.89) supply and demand must fit: *"The number of shoes exchanged for a house [or for a given amount of food] must therefore correspond to the ratio of builder to shoemaker."*
- (p.90) A price is necessary for the exchange.

Jumping about 2000 years, In 1705, in his book "Money and Trade Considered" ([Law05], p. 4), John Law identifies a commodity's value with its price and explains, why the price varies differently from its usefulness. He writes:

*"Goods have a value from the uses they are applied to; and their value is greater or lesser, not so much from their more or less valuable, or necessary uses, as from the greater or lesser quantity of them in proportion to the demand of them. example; water is of great use,*

*yet of little value; because the quantity of water is much greater than the demand for it. Diamonds are of little use, yet of great value, because the demand for diamonds is much greater, than the quantity of them."*

With respect to the function of money he says (p. 6):

*"Before the use of money was known, goods were exchanged by barter, or contract; and contracts were made payable in goods. This state of barter was inconvenient, and disadvantageous. 1. he who desired to barter would not always find people who wanted the goods he had, and had such goods as he desired in exchange. 2. Contracts taken payable in goods were uncertain, for goods of the same kind differed in value. 3. There was no measure by which the proportion of value goods had to one another could be known."*

To my knowledge, Daniel Bernoulli [Ber54] was first to propose the revolutionizing idea that the value of a commodity should be based on its utility instead of its price in 1738:

*"To do this the determination of the value of an item must not be based on its price, but rather on the utility it yields. The price of the item is dependent only on the thing itself and is equal for everyone; the utility, however, is dependent on the particular circumstances of the person making the estimate. Thus there is no doubt that a gain of one thousand ducats is more significant to a pauper than to a rich man though both gain the same amount."*

In 1776 Adam Smith [Smi76] still differentiated, similarly to Aristoteles, between "value in use" and "value in exchange" to explain the Aristotelian puzzle.

Astonishingly, David Ricardo [Ric21] closes his famous book "On the Principles of Political Economy and Taxation" in 1817/21 commenting Adam Smith's thought with the firm statement that

*"Value in use cannot be measured by any known standard; it is differently estimated by different persons."*

Interestingly, the (true) fact that "value in use" is estimated differently by different persons, which serves him as a compelling argument to refuse that "value in use" can be measured at all, served other economists only some decades later, namely Herrmann H. Gossen [Gos54], William S. Jevons [Jev71], Léon Walras [Wal74], and Carl Menger [Men71] to invent the subjective theory of value as the base of modern economics: the value of a good is determined by a subjective judgment of the owner depending on its usefulness within some intended usage context.

## 4.2 External coupling of buyer and seller: the trade

The essential idea of the money mechanism is to extend our preference relation from single commodities to pairs of commodities and money. I call the preferences for which this makes sense "material preferences" (see section 4.7)

Mathematically speaking, being  $M$  the set of money values and  $C$  the set of commodities, then the preference relation  $\succsim \subseteq (C \times M)^2$  relates pairs of commodities and amounts of money. For example, let us assume that we prefer to have 10€ and no cinema ticket over having only 5€ and such a ticket. In symbols: (0 cinema ticket, 10€)  $\succ$  (1 cinema ticket, 5€). In this case we would not pay more than 5€ for the ticket.

Why should we do such an artificial extension of our preference relation? Because we intuitively, that is without reflection, grasp the usefulness of this concept in supporting us in our challenge to coordinate our many social interactions. Part of the money we gain in one interaction we can put on the table in our next interaction. We can now start to realize a lot more actions, according to our original preference relations, because of this money mechanism — why shouldn't we prefer something that makes this possible? So, we can state: money works, because we prefer it to do so as whole subjects.

Next, I apply the introduced two perspectives approach to analyze the network of trading interactions. First, I focus on the interaction perspective of a money-based trade and secondly, I focus on the subject perspective.

### 4.2.1 Buyer

To describe the money-based trade of a commodity  $a$  I first look at a subject in a buyer role that I name "Buyer" or  $B$ . I assume for  $B$ , that she has a certain amount of money, her budget,  $m_{total}^B$ . Her task is now to partition her budget in a way that she acquires her preferred commodity  $a$ . That is, to resolve her preference to acquire  $a$  she has to partition her budget  $m_{total}^B$  into her valuation  $val_a^B$ , which is the maximum amount she would pay to get the commodity  $a$ , and a rest. It holds  $m_{total}^B \geq val_a^B$ . Why doesn't she want to put her total budget on the table? Because this would severely interfere with the coordinating function of money.

To express her preference relation, we represent the relevant state of the world with respect to her possession of commodity  $a$  as a pair  $(n, x)$  where  $n$  is the number of commodities of type  $a$  and  $x$  is the amount of money she possess. We now can relate different pairs of these state values by her preference relation: namely she is indifferent per definition towards  $(0, m_{total}^B) \sim (1, m_{total}^B - val_a^B)$  and — assuming 1 as the unit of money — has the following preferences:

$$(0, m_{total}^B) \sim (1, m_{total}^B - val_a^B) \prec \dots \prec (1, m_{total}^B - 1) \prec (1, m_{total}^B) \prec \dots$$

#### 4.2. EXTERNAL COUPLING OF BUYER AND SELLER: THE TRADE 47

Thus, we can define a utility function, where  $B$  gains from a trade interaction the difference between her valuation  $val_a^B$  and her  $cost_a^B$  to acquire  $a$ .

$$\text{Buyer:} \quad util_a^B = val_a^B - cost_a^B \quad (4.1)$$

We see immediately that for any  $cost_a^B \leq val_a^B$  this function is indeed a utility function for Buyer, as the equivalence  $util_a^B(cost_1) > util_a^B(cost_2) \Leftrightarrow cost_1 < cost_2 \Leftrightarrow (1, m_{total}^B - cost_1) \succ (1, m_{total}^B - cost_2)$  holds.

This model implies that it makes a difference if we buy  $n$  goods at once or sequentially one after the other (without considering time discounting). Buying  $n$  goods at once, we would have to partition our budget into  $n$  amounts with  $m_{total}^B \leq \sum_i val_{a_i}^B$ . Then our valuation would be limited by our valuation of all the other stuff we want to acquire. Buying  $n$  goods sequentially, we would be able to benefit from the last  $i - 1$  good deals we made, where we payed less than our valuation. Thus, our valuation would be limited by the cost the past acquisitions have imposed on us.

We see that the available budget is an essential part of a subject's state it depends on to coordinate his different (economically relevant) interactions.

#### 4.2.2 Seller

Let's turn to another subject in a seller role which I call "Seller" or  $S$ . A seller  $S$  has a certain amount of money  $m_{total}^S$  before the production of commodity  $a$ . For production,  $S$  had to spend a part of his money, his  $cost_a^S$ . With selling he wants at least to get compensated for his expenses. Hence, he is indifferent towards the following possessions  $(1, m_{total}^S - cost_a^S) \sim (0, m_{total}^S)$  and the more money he gets additionally in the trade, the better:

$$(1, m_{total}^S - cost_a^S) \sim (0, m_{total}^S) < (0, m_{total}^S + 1) < \dots$$

Thus, we can define the utility of  $S$ , he gains from a trade interaction as the difference between his  $revenue_a^S$  and the  $cost_a^S$  he has to produce  $a$ .

$$\text{Seller:} \quad util_a^S = revenue_a^S - cost_a^S \quad (4.2)$$

Again, it's easy to verify, that this is indeed a utility function. In economics, there have been many other terms to name these quantities.  $util_a^S$  is also named "profit" or "supplier rent", while  $util_a^B$  of the last section is also named "consumer rent".

#### 4.2.3 The trade

In a trade transaction, the *external* coupling of two subjects in their roles Buyer and Seller is created by the exchange of money and the commodity  $a$ . The coupling condition is therefore the identity between Buyer's cost and Seller's revenue which we name  $price_a$ , together with an increment in the quantity of commodity  $a$  for Buyer and a decrement in the quantity of commodity  $a$  for Seller.

$$\text{External coupling: } \quad price_a := cost_a^B = revenue_a^S \quad (4.3)$$

According to our assumption of freedom of choice, both parties will only agree on this trade if both take at least some utility out of it. Hence, Buyer's valuation as well as Seller's cost determine the possible price range in so far as Seller's cost determine the lowest and Buyer's valuation the highest possible price. Within this price range, this trade constitutes a "win-win"-situation.

The total utility for both together after trading  $a$  at  $price_a$  is just the sum of the individual utilities and does not depend on the price.

$$\text{Total utility (trade): } \quad util_{a,total} = util_a^B + util_a^S = val_a^B - cost_a^S \quad (4.4)$$

Please note that this form of total utility depends on our assumptions of the simple form of Eqs. 4.1 and 4.2 for the utility of Buyer and Seller<sup>1</sup>.

With the assumed utility functions of Buyer and Seller, both parties contribute to the total utility. Buyer with a high valuation and Seller with low costs. As total utility does not depend on the price, the role of the price is only to distribute the utility between Buyer and Seller - hence, the notion of money as a mechanism to distribute utility.

I give an example: A book producer and a book enthusiast have an initial asset of 100€ each, making a total asset of 200€. The book producer now produces a book which costs him 30€, resulting in a remaining asset of 70€ plus the new book. The book enthusiast would give away 90€ of his 100€ to get this book. Both agree on a price of 50€. Subsequently, the book producer has 120€ and the book enthusiast has 50€ and a book he had valued 90€, making an asset of 140€. Together, after the trade, both have a total asset of 260€. The asset grew by the total utility created by the trade of 20€ for the book producer and 40€ for the book enthusiast. So both did benefit from the trade, but not equally.

### 4.3 Trader: Internal coupling of Buyer and Seller

Now we assume that the roles of Buyer and Seller are fulfilled by the same subject, a trader which I name "Trader" or  $T$ , that first buys the commodity and sells it afterwards. We thereby create an *inner* coupling of both roles within one subject with the coupling condition that the commodity has to be bought before it can be sold.

We might think that now, a commodity is first bought and sold second, Trader creates utility twice — but this is not the case. Instead, Trader's cost

---

<sup>1</sup>If we had chosen a monotonously transformed version of both, then the total utility of trade would look different. For example, we could have defined  $util_a^B = \log(val_a^B - cost_a^B)$  and  $util_a^S = \log(revenue_a^S - cost_a^S)$ . Then total utility would have been  $util_{a,total} = \log(val_a^B - cost_a^B) + \log(revenue_a^S - cost_a^S) = \log((val_a^B - cost_a^B)(revenue_a^S - cost_a^S)) = \log((val_a^B - price_a)(price_a - cost_a^S))$ , which would not be independent of the price.



(purchase price) in her both roles of Buyer and Seller are identical. Trader's revenue becomes her valuation in the defined sense of a maximal amount of money she is sensibly willing to pay for the commodity. And thereby, last but not least, also Trader's utility is identical whether we describe her as Seller or Buyer. So, as there is just one person, there is also only one utility.

$$\text{Internal coupling:} \quad util^B = util^S \quad (4.5)$$

Then we could take either formula of Buyer or Seller to get the total utility of Trader as the difference between sale price and purchase price, which obviously depends on the price(s):

$$\text{Total utility of trader:} \quad util_{total}^{trader} = price^S - price^B \quad (4.6)$$

If Trader is a manufacturer who buys a commodity bundle (that is a vector) with  $n$  components and transforms it into another commodity, then this equation does not tell us anything about how the utility is supposed to be distributed among the bought commodity components.

## 4.4 The traditional model

Traditionally, motivated by handling money as any other commodity (see for example [MCWG95, OR20]), the utility representation of Buyer's preferences is modelled a bit differently. First, it is necessary to set a "price" for money, which is usually chosen as 1. Then Buyer's utility is not given as the utility arising from the trade, but as an absolute utility. Before the trade it is the budget  $m_{total}^B$  and after the trade it is the reduced budget  $m_{total}^{B'} = m_{total}^B - cost_a^B$ , supplemented by her valuation  $val_a^B$ :

$$\text{Buyer:} \quad util'_a{}^B = m_{total}^{B'} + val_a^B. \quad (4.7)$$

Thus, the dependence of the utility function from the trading cost occurs indirectly through the dependence of the total budget from this cost.

This is indeed a utility representation of Buyer, as again the equivalence  $util'_a{}^B(cost_1) > util'_a{}^B(cost_2) \Leftrightarrow cost_1 < cost_2 \Leftrightarrow (1, m_{total}^B - cost_1) \succ (1, m_{total}^B - cost_2)$  holds.

However, the appearance of the total budget is a bit unsatisfying already at this stage, as the essential dependency on the cost occurs only implicitly, while the obvious dependency of the valuation from the total budget is not mentioned, although this variable now occurs explicitly in the formula. Lets see what the consequences are for the external and internal coupling of Buyer and Seller.

For the external coupling of Buyer and Seller in a trade, we then get the total utility as before, but with an additional dependency on Buyer's budget:

$$\text{Total utility' (trade):} \quad util'_{a,total} = util'_a{}^B + util_a^S = m_{total}^B + val_a^B - cost_a^S \quad (4.8)$$

However, with this utility representation, the internal coupling of Buyer and Seller in a trader does not work, as the internal coupling condition  $util^B = util^S$  does not hold any more.

To rescue this utility representation, we would have to supplement the utility function of Seller also with his total budget. But within a circular economy where everyone is Buyer and Seller, this would lead to double counting of the budgets of Seller and Buyer in the total utility summation.

Thus, a model that treats money as an ordinary commodity, except its linear utility representation, where utility is somehow attributed to all commodities and therefore also to money, is not compatible with a holistic view on economic subjects. Such a holistic view, which takes into account all of the subject's interactions in its roles and the coordination of its roles, prohibits a utility scale in an absolute sense.

Thereby money loses its interpretation of being "crystalline utility", but it becomes *the* mean to transfer utility in a trade. Whether it does so depends on the mentioned preconditions and to what extent depends exclusively on the valuation of Buyer and the cost of Seller. A trade is not a symmetric, but an asymmetric situation with respect of the exchanged items. If we buy a kilo apple for 2€, its not that the price of the apple is 2€ per kilo apple and the price of the money is 2 kilo apple/€. Instead the price is part of the external coupling condition of the trade which consists of a) exchanging 2 kilo apple at a price of b) 2€ and it determines how strongly the trading partners could express their preferences.

## 4.5 Money as a utility transfer mechanism

In the last two sections we have seen that our assumption of two simple utility function definition for Seller and Buyer in a trade interaction together with the coupling condition of a "price", lead to a simple form of total utility, which was independent of the price.

This function of money to work as a utility transfer mechanism is well known in economics (see for example [Mye91], pp. 384), but, as far as I can see, not the combination of interaction and coordination.

Up to now, the assumed form of the utility functions is in fact ad hoc. As we have learned, any combination of a monotone function together with the assumed utility function would also have resulted in a valid utility function — but would not have lead to the simple form of total utility, independent on the price.

Also, the assumption that the total utility generated by a trade is just the sum of the utility of Buyer and Seller is ad hoc. Again, any combination of an additional monotone function together with the assumed sum-function would also have resulted in a valid total utility function.

But we have introduced utility not as something to look for in the brains of people or other animals, which may be encoded differently in every subject by its neurons and perhaps accessible by introspection, but as a concept to simplify our

reasoning about subjective preferences under well defined circumstances. Thus, we can use the freedom of the utility concept not to insist on any particular form, but to choose exactly that form which makes the interpersonal comparison of utility meaningful and thereby allows us to compare preferences interpersonally.

I now show that the utility representations I introduced for Seller and Buyer are the only ones that fulfills our three trade-constraints as well as the trader constraint. First, I define:

**Definition 8.** *A money based trade between Seller and Buyer is a mechanism which fulfills the following constraints:*

- *Trade-interaction constraints:*
  - (a) *The utility of Buyer depends only on the difference between her valuation and her costs:  $util_a^B = f(val_a^S - cost_a^B)$ , and becomes zero if her valuation equals her costs,  $f(0) = 0$ , and becomes her valuation if the costs are zero,  $f(val_a^S) = val_a^S$ .*
  - (b) *The utility of Seller depends only on the difference between his revenue and his cost:  $util_a^S = g(revenue_a^S - cost_a^S)$ , and becomes zero if his revenue equals his cost,  $g(0) = 0$ , and becomes his revenue if his costs are zero,  $g(revenue_a^S) = revenue_a^S$ .*
  - (c) *The total utility resulting from the trade as the sum of the utility of Seller and Buyer is the difference between Buyer's valuation and Seller's cost and is therefore independent of the price:  $util_a^{Total} = util_a^B + util_a^S = val_a^B - cost_a^S$ .*
- *Trader constraint: The utility of Trader is independent of whether we look at her as Seller or Buyer.*

The claim is now,

**Theorem 1.** *The utility functions of Seller and Buyer in a trade interaction according to Def. 8, namely  $util_a^S$  and  $util_a^B$  is given by equation 4.1 and 4.2.*

To prove this theorem, we first have to provide the general utility functions for Seller and Buyer in a trade interaction. As we have seen,  $val_a^B - cost_a^B$  is a possible utility function of Buyer and  $revenue_a^S - cost_a^S$  is a possible utility function of Seller. Then, the general utility functions for Buyer and Seller are provided by two additional monotonous functions  $f, g : \mathbb{R} \rightarrow \mathbb{R}$  such that

$$util_a^B = f(val_a^B - cost_a^B) \quad (4.9)$$

$$util_a^S = g(revenue_a^S - cost_a^S) \quad (4.10)$$

Now, the trader constraint requires both function to be identical:  $f = g$ . And the external coupling condition (Eq. 4.3) makes the first constraint to

$$util_a^{Total} = util_a^B + util_a^S = f(val_a^B - price_a) + f(price_a - cost_a^S)$$

With the next lemma, we prove that this requires  $f$  to be linear with zero intercept.

**Lemma 1.** *Be  $a, b, c \in \mathbb{R}$  with  $a \geq b \geq c$  and  $f(a - b) + f(b - c) = f(a, c)$  not depending on  $b$ , then  $f$  is a linear function.*

*Proof.*<sup>2</sup> We can chose  $b = (a + c)/2$  and get  $f(a - b) + f(b - c) = 2f((a - c)/2)$ . This value even depends only on  $a - c$  and not on  $a$  and  $c$  individually. As  $f(a - b) + f(b - c)$  is supposed not to depend on  $b$  at all, this value holds for every  $b$ .

Substitution of  $x = a - b$  and  $y = b - c$  results in

$$\frac{f(x) + f(y)}{2} = f\left(\frac{x + y}{2}\right) \quad (4.11)$$

for all  $x, y \geq 0$ .

I first show the linearity for rational coefficients and in a second step extend this result to general real numbers.

W.l.o.g. be  $f(0) = 0$  (The general case with  $f(0) \neq 0$  can be reduced to this one by taking  $g(x) = f(x) - f(0)$  and looking at  $g$  instead.)

With induction I prove that  $f(nz) = nf(z)$  for all  $z \geq 0$  and  $n = 0, 1, 2, \dots$ . The case  $n = 1$  is trivial. For the induction step, set  $x = 2nz$  and  $y = 2z$  in Eq. (4.11). Then  $(n + 1)f(z) = nf(z) + f(z) = \frac{2nf(z) + 2f(z)}{2} = \frac{f(2nz) + f(2z)}{2} = f\left(\frac{2nz + 2z}{2}\right) = f((n + 1)z)$ .

By substituting  $z$  with  $\frac{z}{n}$  in  $f(nz) = nf(z)$ , we get  $f\left(\frac{z}{n}\right) = \frac{f(z)}{n}$  for all  $z \geq 0$  and  $n = 1, 2, \dots$

Together we then have for the rational coefficient  $q = \frac{m}{n}$  with  $m, n = 1, 2, 3, \dots$ :  $f(qz) = qf(z)$ .

To extend this result to general, real coefficients I refer to the fact that  $\mathbb{R}$  is a  $\mathbb{Q}$ -vector space. That is, every real number can be given as a linear combination of an (uncountable) index-set  $\{p_i\}$  of real numbers with rational coefficients.

Be  $a = \sum_i \alpha_i p_i$ ,  $b = \sum_i \beta_i p_i$ ,  $c = \sum_i \gamma_i p_i$  three elements of  $\mathbb{R}$  with the sets of rational coefficients  $\{\alpha_i\}, \{\beta_i\}, \{\gamma_i\}$ . We then have  $f(a - b) + f(b - c) = f(\sum_i \alpha_i p_i - \sum_i \beta_i p_i) + f(\sum_i \beta_i p_i - \sum_i \gamma_i p_i) = \sum_i f((\alpha_i - \beta_i)p_i) + \sum_i f((\beta_i - \gamma_i)p_i) = \sum_i (\alpha_i - \gamma_i)f(p_i) = f(\sum_i \alpha_i p_i - \sum_i \gamma_i p_i) = f(a - c)$ .

What remains is to show that  $f(x + y) = f(x) + f(y)$  which results from replacing  $x$  and  $y$  in Eq. (4.11) by  $2x$  and  $2y$ .  $\square$

Thus,  $f$  is a linear function. To complete the proof of our theorem, we note that together with our boundary conditions  $f(0) = 0$ , and  $f(val_a^B) = val_a^B$ ,  $f$  has to be the identity function.

We have just proven that if we view money as a utility transfer mechanism, our money based preference relation has to be linear in the money component. Considering money as a commodity like any other, it was Léon Walras who discovered this peculiar aspect of money and coined the term "numeraire" [Wal74] for the money term. Economists traditionally say that our preferences are "quasilinear" with respect to the commodity money, which just means that they are linear in the money term and arbitrary in any other term.

<sup>2</sup>This proof is due to Martin Härterich

As said before, I think that it is misleading to view money as a commodity like any other, as long as it is used for its essential function to transfer utility in a social interaction mechanism to exchange commodities. However, as we all know, money can itself become subject to trade, for example in buying and selling foreign currency.

Two consequences from the linear utility representation of money are well known (see e.g. [MCWG95], p. 45):

1. if Buyer is indifferent with respect to two bundles  $x, y \in \mathbb{R}^n$ ,  $x \sim y$ , then any additional amount of money (component 1) does not change that:

$$(x + \alpha e_1) \sim (y + \alpha e_1), \forall \alpha \in \mathbb{R}, e_1 = (1, 0, \dots, 0) \quad (4.12)$$

2. Money (component 1) is desirable in the sense that everything else constant, we prefer more money over less money:

$$(x + \alpha e_1) \succ (x), \forall \alpha > 0 \quad (4.13)$$

This is what our intuition about money is about. If money works as intended, then, in contrast to ordinary goods, money should have no influence on our preference relation of these goods. And, it should always be better to have a bit more than a bit less money. Actually, these are two well testable propositions for the validity of our money model.

Please note that in the presented model even though money can transfer utility in the defined sense, it does not represent or measure utility in the sense that the more money I have, the more utility I have gathered. So, the statement "money is transferable utility" is false in this model. Instead, individual utility manifests itself on both sides of a trade only as a difference between some sort of revenue/valuation and some sort of cost.

## 4.6 Money's coordinating function

A direct consequence of the coordinating function of money on a large scale is demonstrated by the three different calculations which all result in the gross domestic product: measuring societal production, expenditures and income (see section 4.8.1).

For money to fulfill its coordinating functions, several problems have to be solved, some quite practical and some more fundamental. Let's start with the practical ones. Assuming that an individual expresses her material preferences with her money, then the coordinating function of money is additionally based on the simple fact that she can spend each euro only once. This is the case if Seller can verify the authenticity and past ownership of the currency and Buyer cannot replicate it (see the double spend problem of electronic currencies [NBF<sup>+</sup>16], pp. xiv).

It's also important that the costs for the mechanisms to guarantee these properties remain low compared to the value the money represents in the transactions, as money-mechanism costs reduce total utility. Examples of "currencies" that created high such costs have been gold-based currencies or the new crypto-currencies like bitcoin.

A more fundamental problem is what I call the *private public money distribution (PPMD)* problem, which concerns the question of whether to provide economic subjects with equal or different budgets (see section 7).

## 4.7 What we can and what we can't buy

Without doubt, we cannot buy everything for what it is worthwhile to make an effort, but only certain things. The reason is that a money-based direct exchange relation of trade requires either a definable product that can sensibly be owned and whose ownership can be transferred, or a sufficient clearly defined service so that it can sensibly be provided by a service provider to a service consumer.

And last but not least – very importantly – it has to be the object of a non-hierarchical preference. As I have already said in section 4.2, I qualify preferences that are directed towards things that can be exchanged for money as "material" preferences.

### 4.7.1 What we cannot buy – at least not directly

If we look at all the necessary preconditions that have to be fulfilled to enable things to become subject to our material preferences, it is easy to identify a lot of things we cannot directly buy in a trade interaction, although they might still be highly preferable to us.

Some things may be material but are a common good, owned by nobody but available to everyone, for example our air to breathe.

Other important things could be technically owned, but it is forbidden to view them as goods, for example humans. However, to abolish slavery is a comparably new phenomenon. In the British Empire, slave trading was prohibited in 1807 and slavery itself was abolished in 1833 (with the notable exception of the territories of the East India Company, Ceylon and Saint Helena.) In the USA, slavery was abolished only in 1865 as a result of the civil war. Nazi-Germany enslaved millions of people during the second world war 1939-1945. In some Arab countries like Yemen and Saudi Arabia it took until 1962 and in Mauritania until 1980 [Kle14]. But still today, human trafficking and slavery is a major world wide problem [KSJ<sup>+</sup>18]. The International Labour Organization (ILO) together with the Walk Free Foundation estimate for 2016 that 40.3 million people are in "modern" slavery, including 24.9 million in forced labour and 15.4 million in forced marriage [ILO17].

Interestingly, Adolf A. Berle and Gardiner C. Means discussed in their seminal book "The modern corporation and private property" [BM33] the consequences of the increasing power of modern companies up to the dimension of

modern states (p. 1): "Spectacular as its [the modern corporation] rise has been, every indication seems to be that the system will move forward to proportions which would stagger imagination today [1933!]" How true. And relating to thoughts of Walter Rathenau, as a consequence to the observed increasing detachment of the property and possessor in these large corporations they sketched (pp. 352) as a solution to this problem a notion of the modern corporation that serve not alone the owners nor its management, but "all society", where "the interest of passive property owners would have to give way" – only a small step ahead of the idea of abolishing ownership of economic legal persons entirely.

But despite these thoughts, there is still consensus that some legal persons can be owned, despite their necessary social and economic autonomy. In fact, in Germany, according to GG §19(3), the constitutional rights explicitly hold also for legal persons, "as appropriate" – whatever that means. Notably, in the USA, the supreme court ruled in its 2010 *Citizens United v. Federal Election Commission* decision that the freedom of the press clause of the First Amendment of the United States Constitution also protects associations of individuals like corporations [otU10]. Knowing that, most people are surprised to learn, that actually most legal persons like associations, foundations or public corporations already cannot be owned! It is only stock companies and private limited companies where the rules of law keep up the fiction of ownership. Thus, one is inclined to assume that a small change in the juridical interpretation of what is "appropriate" may lead stock companies and private limited companies out of their anachronistic state of slavery.

However, together with its ruling in the *SpeechNow.org v. FEC* case, also in 2010, the US Supreme Court fundamentally changed the effective political campaign finance rules in the USA, leading to a dramatic increase in political campaign expenditures [Gar11]. In my opinion this is a good example how the concept of "autonomy" can be misused if we do not look at the person as a whole, as the money collecting corporations are surely not autonomous in a true sense, but just have to exert political influence in the sense of its sponsors.

Also, there are services which can be clearly defined, but that are also forbidden, because society has discovered that they dramatically interfere with efficiency or effectiveness, for example services in association with fraud, bribery and corruption. Or they are viewed to be incompatible with human dignity, like in Sweden and other countries the imposition to offer someone money for sex.

In addition, the service notion in the sense of a service provider and a service consumer is inappropriate for a large class of economic relevant interactions. We describe economic interactions as games and therefore we can expect economic interactions to be at least as rich in their structure as parlour games. But with more complex interaction structure, the "direct exchange" character of the interaction gets lost and the role of money changes.

Some things can be owned but the ownership cannot be directly transferred, first and foremost meaning! In my opinion it is one of the greatest achievements of modern science to have developed a concept of communication that clarifies what can be measurably transported in communication, namely information, and what cannot be transported, namely meaning [Sha48]. According to this

theory, meaning is always attributed locally by information processing, or, as I prefer to say in this context, by local interpretation. An uninterpreted world is meaningless [Rei20b]. Of course one can try to impart upon people the ability of interpretation, but as most parents and teacher will acknowledge, there is no guarantee.

Our inability to directly transfer meaning has enormous consequences for what we can buy and what we cannot buy. For example, we cannot buy values and culture, as they are deeply rooted in our interpretation ability. The same holds for cultural things like democracy. But, despite the fact that we can't buy or sell such things directly, the way a society deals with money is surely a decisive component to which values and which culture will be viable.

#### 4.7.2 What we can buy: different goods and their characteristics

The value of a good does not stick to it like its mass but is attributed by us depending on our chosen usage context. We can classify goods with respect to our valuation relating to a usage context according to different, not necessarily independent criteria.

A first characteristic is the valuation's evolvement in time. We can roughly distinguish three classes of goods: store of value, long-lasting, and short-lasting goods. Store of value goods increase in value over time after they have been bought, like [sometimes] stock or [also sometimes] a new cello. Long-lasting goods retain a significant amount of their value for a long time, like machines. And short-lasting goods lose their value within a relatively short time frame, for example by annihilation through consumption or because of their volatile character as in the case of a theater visit.

Then we can distinguish between goods that are used to produce other goods, so called capital goods, and consumption goods that are produced for consumption, either in production processes or for individual consumption. Due to their involvement in the production process, the valuation of capital goods must live on a significantly larger time scale than consumption goods. The oven a baker has to buy for baking his bread will live significantly longer than the bread that is sold today and consumed tomorrow.

Another important dimension is the scaling behaviour of our valuation with the number of goods. A typical scaling behaviour of the value of a consumption good in an industrial mass production context is approximately linear over a large number range. A typical scaling behaviour of the value of a consumption good in an individual context is a fast saturation or even decreasing valuation with increasing number. For example, within a wide range, the amount of bread a bakery can produce is a linear function of the available amount of flour, but the amount of bread one can consume is – independent on the individual's wealth – very limited. Perhaps, it is a good definition of the "industrial" character of production to have a production context with a large range of linear cost scaling aggregating many small nonlinear valuation ranges of consumers.



Then there are scarce and abundant goods. The amount of a scarce good is limited and therefore its ownership implies competition. A good example are diamonds. The amount of abundant goods is virtually unlimited. A good example are information goods, which could be – at least in principle – made available virtually to everyone. However, using legal constructions like intellectual property, modern societies put a lot of effort in not doing so.

Then there are complementary and substitute goods. Goods are complementary if we value them as a bundle more than the sum of their valuations as single items. For example, a video cassette has a higher value if we also possess a working video recorder. And the value of a telephone increases with every other telephone which can be reached. Economists talk about externalities or network effects. Goods are substitutes if having one good makes us wanting the other less, that is, we value them as a bundle less than the sum of their valuations as single items.

## 4.8 Material wealth

I define material wealth as the sum of material value. How is material value generated? By the valuation of the economic subjects in their social context.

For commodities we want to use ourselves, we have defined their valuation as the amount of money where we become indifferent between holding it without that money compared to not holding it with the money. According to our theory, that things do not change if we change the perspective, its no surprise that the same holds true if we view us as being a potential seller. Then we can view this amount as the minimal amount of money someone would have to offer us such that we would become willing to give it away instead of using it ourselves. However, there are two differences between a pure producer and a user: first, for the producer, not selling means making a loss, while for the user, not selling means further usage. And secondly, while the producer can calculate its cost the user can only estimate his valuation.

We now can represent all sorts of material things that we could possibly own by a vector  $(n_1, \dots, n_N)$  with  $n_i$  the number of things of a sort. Then we sum up the valuation of all things to get our wealth as the total value that we own.

According to our model, free trade increases the overall wealth, as it transfers goods from people with lower valuation to people with higher valuation.

A trade that transfers a good that keeps its value for the buyer for a longer time will increase overall wealth more than a trade of a good that loses its value for the buyer quickly. One reason why investments into education raise societal wealth much more than many other investments [Woe16], for example into cigarettes.

So, a society does not become material wealthy because it accumulates money, but because it uses money based trade to stimulate people to most efficiently create as many commodities as possible which are then transferred by trade to as many people as possible valuating them for as long as possible. Thus, money can be viewed as a lubricant for the social mechanism to transfer

commodities to where they are valued most. As with any other lubricant, it is not just its existence that counts, but how it is distributed and also its turn over velocity.

I would expect societies to differ wildly in their ability to use money to effectively build up material wealth. Its not the finite natural resources that limits this process, but its material wealth limit should be determined by society's wealth creation ability and its valuation decay rate.

Beside such general statements with respect to the change of wealth, the determination of wealth in any absolute sense is quite problematic because of several obvious reasons.

First, uncertainty: it depends entirely on estimations. For most of the goods we own, we might have never spent a glimpse of a thought selling them. So, how should we quantify such a value? Even for material things we want to sell, our valuation is an estimation, a prediction of some future trade result. And the  $n : m$ -relation between input and output materials of modern production makes this estimation even more difficult.

Second, fragility: On the one hand, if we discover out of the blue something material we value high - we have become wealthier! But on the other hand, our esteem might change fundamentally also in the other direction because of changed circumstances. For example, assuming that we own an oil platform worth a billion € today, we will have to re-valuate it if it explodes tomorrow. Or if we own a large plane fleet and suddenly a pandemic ceases all flight traffic. Or all the combustion engine driven cars in the face of global warming. Or all the investments, Europe put into its military before 1914 — the pride of these societies — turned out to be a gigantic value destruction machinery during the first world war. So, what is a valuable asset today could be worthless, or even a huge cost factor, tomorrow.

Third, inequality: the more unequally the material goods are distributed, the less meaningful is an aggregation of the valuation estimated in this way across different persons. What sense does it have to compare the valuation of a second Island and a third yacht by a billionaire, which are used mainly to impress her fellow billionaires and the valuation of a small apartment, used for living 24x365 by a craftsman?

And forth, our valuation of unbuyable goods: Although we cannot buy peace, democracy, freedom, justice, etc directly, we usually try to establish or keep them by investing some money in supposedly effective procedures to support them. How should we value these properties of our social world?

In summary, our theory implies that material wealth is a complex and fragile subject due to its subjective nature. Thus, the development of material wealth should profit enormously from societal stability without disruptive re-valuations. This hints at a huge advantage for material wealth accumulation for open societies of economically (truly) free individuals that succeed in maintaining a social consensus on a large time scale.

### 4.8.1 What does the gross domestic product (GDP) indicate?

Let us just briefly compare these considerations with one of the most widespread modern indicators of societal "wealth", the gross domestic product (GDP). The measurement of the GDP is defined by the so called "System of National Accounts", maintained collectively by the UN, the European Commission, the OECD, the International Monetary Fund and the World Bank Group [UEO<sup>+</sup>08].

Expressing its coordinating function of money on a societal scale, the GDP can be calculated in three different ways, mirroring the production, the income and the expenditure view on the yearly traded commodities and the corresponding money flow in a society.

1. **Creation (production approach):**  $\text{GDP [at producer price]} = \text{gross value of output [at market prices]} - \text{value of intermediate consumption [at market prices]} + \text{indirect taxes} - \text{subsidies on products}$ .
2. **Usage (expenditure approach):**  $\text{GDP} = \text{consumption} + \text{investment} + \text{government spending} + (\text{gross exports} - \text{gross imports})$ .
3. **Distribution (income approach):**  $\text{GDP} = \text{compensation of employees} + \text{gross operating surplus} + \text{gross mixed income} + \text{taxes} - \text{subsidies on production and imports}$ .

There are numerous, well known deficiencies of the GDP. For example it does not cover household and other unpaid work — although it covers unpaid rent due to residential property by estimations.

As the definition of the GDP is based on the price of the goods and services and not on their valuation, it cannot, per definition, measure wealth. Instead, in my opinion, it measures the economic power. And it documents the coordinating function of money on a societal scale as the balance between societal income, expenses and production shows.

The relation between economic power and economic wealth is similar to that of work performance and achievement: you have to work a lot to achieve something substantial, but you also might work in vain and achieve nothing, or even contribute to destruction. A "throwaway society", that is, a society creating lots of commodities with rather short duration of valuation, can be (much) poorer despite a higher GDP than a comparable society with a lower GDP, but producing more sustainable products. Actually this is well known, and as a result, there is a thorough discussion about further economic indicators to more validly estimate societal wealth (see for example [LB14], chapter 15, or [SSF09]). The direct relevance of the difference between economic power and societal benefit can be seen in the healthcare sector, where both, the effort, in terms of percentage of the GDP spent, and the outcome, in terms of life expectancy, infant mortality, obesity, etc. can be measured. I provide some figures in section 5.2.3.



## Chapter 5

# Price determination

As the total utility of a trade is per definition independent of the price, the two equations of trade (4.1) and (4.2) do not determine the price. Instead, they provide a more or less large interval into which the price has to settle, a space of freedom that can be and has to be filled by further mechanisms, the mechanisms of price determination.

In the following I will ponder about several intricacies of fair distribution and price determination mechanism like markets. I have chosen markets because of their textbook character. There are many more like auctions or Vickrey–Clarke–Groves mechanism (see for example [Rou16] for an introduction), each with its own strengths and weaknesses.

### 5.1 Fair prices

As the utility distribution of the price mechanism directly relates to the personal preferences, a simple logical conclusion is the existence of a "*fair*" price in the sense that the utility of a trade is divided 1:1 between Seller and Buyer.

It is immediately apparent, that if a price can be fair, it can also be unfair to an arbitrary degree. Although a free trade is, per definition, a win-win-situation, it nevertheless can be arbitrarily unfair, where the advantageous party can somehow suck almost all utility from the wronged party. We thereby get a glimpse of the power of money as a mechanism to distribute utility. We might be able to design it such that it distributes utility by and large fairly — or we might design it willingly or unwillingly to become a mechanism to distribute utility systematically in an extremely unfair manner.

#### 5.1.1 Fairness in 1:n relations

What happens, if Seller sells his good not to a single but to  $n$  Buyers? The first thing we have to realize is, that reasoning over this case, we aggregate utility of different subjects. The validity of our reasoning therefore depends on

the validity of our assumptions, that everyone has the same total budget and has the same access to all relevant alternatives. Otherwise we might still add numbers, which look like "utility" but the resulting aggregates have lost their relation to the preferences of the people we were considering.

I will show next, that in the collective case the order of utility partition and price determination plays a decisive role.

The first possibility is to average utility first and then to distribute it evenly by deriving the individual prices thereof. Let us look again at the book producer who now produces 2 books at 30€. There are two book enthusiasts, one with a valuation of 90€, the other, a bit less enthusiastic, with a valuation of 60€. The average total utility then is total valuation minus total cost divided by the number of participants  $(90€ + 60€ - 30€ - 30€)/3 = 30€$ . If the first book is sold for 60€ and the second book for 30€, every participant gets off with the average utility of 30€. In summary, we proceeded in two steps:

$$\begin{aligned} \text{Step 1 [Determine average utility]:} \quad & \bar{u} = \frac{1}{n+1} \sum_i (val_i - cost_i) \\ & = \frac{n}{n+1} (\overline{val} - \overline{cost}) \\ \text{Step 2 [Determine } n \text{ prices]:} \quad & p_i = val_i - \bar{u} \end{aligned}$$

Thus, for increasing  $n$ , the average utility everyone realizes, converges against the difference between the average valuation and the average cost.

The second possibility is to determine the local "fair" price in each trade directly and afterwards look at the utilities of every participant. As Seller takes part in every trade interaction, he now gets his share  $n$ -times. The first price would determine to 60€ and the second price to 45€. The utility of the first Buyer would be 30€, of the second Buyer 15€ and for Seller it would be 45€.

$$\begin{aligned} \text{Step 1 [Determine } n \text{ prices]} \quad & p_i = (val_i - cost_i)/2 \\ \text{Step 2a [average utility of the } n \text{ buyers]} \quad & \bar{u}^B = \frac{1}{n} \sum_i (val_i - p_i) \\ & = \overline{val} - \bar{p} \\ \text{Step 2b [utility of seller]} \quad & u^S = \sum_i (p_i - cost_i) \\ & = \sum_i u_i^S = n\bar{u}^S \end{aligned}$$

The average utility for all participants is in both cases identical, but the distributions are different. Now all Buyers get on average the difference between their average valuation and the average price, and Seller accumulates all utilities from each trade.

So, in the first case all participants benefit equally, in the second case, Seller's total utility increases with the number of Buyers (or sold items) and thereby shows the same scaling behaviour as with a constant price for all trades.

Obviously, considering fair division of utility, we have to distinguish between "local" fairness on an individual trade interaction scale and "global" fairness on a group scale and we should be careful not to take the one for the other.

As I will discuss later in section 6, this distinction becomes of great relevance

at a company employing  $n$  employees.

### 5.1.2 Fairness today and tomorrow

Another hurdle for fair prices are the uncertainties of Buyer's valuation. While Seller's costs are fixed at the time of trade, Buyer's valuation is an estimation referring to some future state and which usually changes over time (see also section 4.8). Perhaps our book enthusiast who was just willing to pay 90€ for the book reads the first few pages and changes her mind, now thinking: "Oh what a rubbish! Never ever again should I spend any cent on this kind of trash!" With this re-valuation she has cut her wealth in one swoop by 90€ as she now possess only 50€ together with a book where she would not even pay a single cent for, which even may create costs for disposal. Phillip Nelson [Nel70] introduced the term "experience good" for goods whose value can be accurately estimated only after they have been experienced.

So, value is created in the eye of the user and this value is quite fragile. What seems to be valuable today doesn't need to be valuable tomorrow and therefore what seems to be fair today need not to be fair tomorrow.

### 5.1.3 Privacy and robustness concerns

Guaranteeing fair prices would also imply for Buyer a need to reveal her private information of valuation and for Seller to reveal his private information of production cost. Do they want to reveal this kind of information? And, if they do so, how do we know that both tell the truth?<sup>1</sup> And, as the production costs occurred in the past they might be determinable, but as we have seen, valuation is just an estimation. And obviously, asymmetric knowledge of Seller about Buyer's cost and especially of knowledge of Seller of Buyer's valuation is a very good starting point for any form of exploitation.

Assuming a "fair" price in the defined sense also opens a simple manipulative way to enlarge Seller's piece of the cake, just by positively "influencing" Buyer's valuation.

### 5.1.4 A preliminary conclusion

Despite the many difficulties with fair pricing, there are relevant real pricing models that follow the fairness pattern at least a bit. For example the price a newspaper publisher has to pay to get news from the Deutsche Presse Agentur (dpa) depends on its circulation size. Interestingly, the dpa is owned by more than 300 publishers, none is allowed to gain more than 1.5%. So owners and customers are mostly the same.

---

<sup>1</sup>Interestingly this is possible, for example in so called sealed bid second price or Vickrey auctions [Vic61], which combines allocation and pricing rules in a way that each Buyer must provide her valuation as an offer if she wants to maximize her utility and Seller must reveal his cost as a minimum price to optimize his utility.

We often find these staggered pricing scheme as member fees for companies in industrial associations, for example depending on their number of employees or on their revenue. Or, the entry into a museum is often much cheaper for children than for adults

Also, in the software business, with low marginal production costs, very often companies distinguish between private and commercial usage, where private usage is much cheaper or even free of charge, while commercial usage has to be payed for<sup>2</sup>.

Another example where fair pricing seems to be relevant is the "pay-what-you-want" pricing schema, realized for example by donation after the concert of the symphony orchestra of a municipal music school (e.g. [SSZ14]).

An important area where our model is actually applied is fair division, or "cake cutting", where some items are to be divided between different participants. Here money in our sense can be used to solve the problem of fair division even if the goods are indivisible (e.g. [BMS20]).

All in all, I think the most important aspect of our fairness consideration is, that it essentially depends on the assumption of an identical budget and identical access to all relevant alternatives. Only then we can define a fairness criterion against which price determining mechanisms can be measured. Also, it is very important that we understand the difference between local and global fairness and see that the latter is much more important.

As important pricing and distribution mechanisms with highly desirable properties, like markets, are fairness-agnostic, it is necessary to think about global fairness and global redistribution mechanisms by which we can at least approximately establish the preconditions to judge local fairness.

## 5.2 Maximizing collective utility: markets

As we have discussed in section 4.2, the price of a single trade does not influence the total utility that the trade creates. Interestingly, this is not the case for collective trading at a single price, as then this price determines the number of possible trades.

### 5.2.1 Collective trading

If we look at  $n$  Seller-bByer-pairs, we could look at each of them individually. Then as many prices would be realized as there are pairs of sellers and buyers. None of the prices would influence total utility. But how does the pairing occur? Randomly? This would lead to many pairings where no trade would be possible, because Seller's cost surpasses Buyer's valuation.

It is therefore more clever to create a market by swapping price determination and pairing — or grouping, as I might say — and group first and determine the

---

<sup>2</sup>Although there may be additional reasons for this pattern, like a marketing strategy. However, it could be that the suggested sense of fairness might be one of the reasons for the success of such a marketing instrument.



prices second. Actually, as a result, a single price, the so called "market clearing price" can be determined where demand meets supply.

For this purpose, we rank (or order) all Sellers according to their cost of individual commodity pieces and all Buyers according to their valuation per piece of commodity. Thereby we create two functions:

1.  $cost : \mathbb{N} \rightarrow \mathbb{R}$  where  $cost(j)$  gives the cost of the  $j$ -th piece of a Seller with this rank, or the largest cost of a piece that was achieved producing the least costly  $j$  pieces.  $cost$  has a minimum value of the lowest possible cost of production and is per definition monotonously increasing.
2.  $val : \mathbb{N} \rightarrow \mathbb{R}$  where  $val(j)$  gives the valuation per piece of Buyer of rank  $j$ , or the smallest valuation of a piece that is provided by the set of the  $j$  highest valuations.  $val$  has a maximum value of the highest occurring valuation and is per definition monotonously decreasing.

As is illustrated in the left part of Fig. 5.1 we pair Seller and Buyer of rank  $j$  and calculate the resulting utility of rank  $j$  as  $util(j) = val(j) - cost(j)$ . The total utility can then be calculated by summing all utilities up to the last rank  $j_{max}$  we could build by pairing:  $util_{total} = \sum_{j=1}^{j_{max}} util(j)$ :

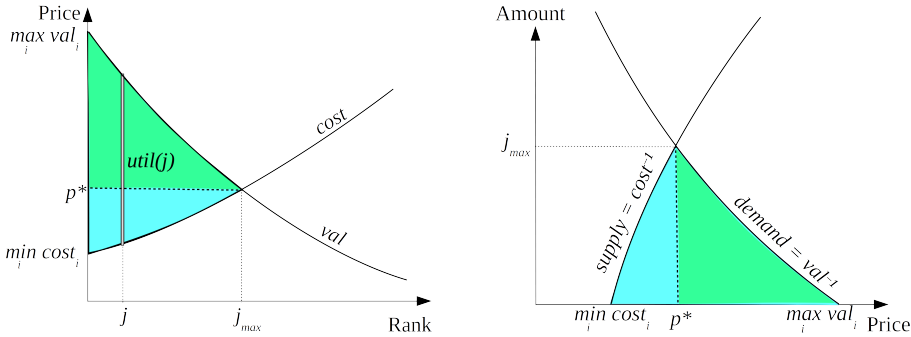


Figure 5.1: On the left side, the  $cost$ - and  $val$ -functions are illustrated, where all Sellers are ordered according to their costs and all Buyers according to their valuation. On the right side the inverse functions, representing supply and demand are shown. The green area shows the total utility of all Buyers, and the turquoise area shows the total utility of all Sellers.

If there is a crossing point of both graphs, then there is a natural price  $p^*$  at which the maximum number of trades can happen. The total utility, also called Marshallian surplus, that is gained by all trades is the colored area in Fig. 5.1. The upper, green area represents the total utility flowing to all buyers, the so called "consumer rent" and the lower turquoise area represents the total utility flowing to all sellers, the so called "producer rent".

A missing crossing point of both graphs implies a lack of supply or demand and leaves the price a leeway

The market price is the price where the total utility for all participants reaches its maximum. This is a stronger statement than proposing that a market price represents a "Pareto-efficient" solution in the sense that no one can change its choice without rendering herself being worse off.

The solution is quite stable against changes in the extremes, comparable to the median of a distribution. Thus, it is a good approximation that having enough Sellers and Buyers, none of them can significantly influence the market price by strategic manipulation. The questions is then for all Sellers and Buyers, how much should they produce or consume at a given market price  $p^*$  to maximize their individual utility.

Note, that after the price is determined, other pairings are possible without changing total utility, as long as the same maximal rank is achieved, a direct consequence of the utility-transferring property of money.

As already stated at the end of the section 5.1.4 the market mechanism is completely fairness-agnostic.

### 5.2.2 The clearing function of markets

There is a well known important additional interpretation of the relation between the *cost*- and *val*-functions, which becomes obvious if we look at their inverses, as shown in the right part of Fig. 5.1. The inverses of both functions can be interpreted as

1. *supply*(=  $cost^{-1}$ ) :  $\mathbb{R} \rightarrow \mathbb{N}$ , which counts the number of commodities that can be produced at least at a certain cost. It is per definition monotonously increasing. That is, the higher the price, the more commodities can be produced at least at that price.
2. *demand*(=  $val^{-1}$ ) :  $\mathbb{R} \rightarrow \mathbb{N}$ , which counts the number of commodities that are valued at least a given value. It is per definition monotonously decreasing. That is, the lower the price, the more commodities are valued at least at that price.

We can therefore state the well known clearing function of a market with the market price  $p^*$  as the price, where supply meets demand:

$$supply(p^*) = demand(p^*) \quad (5.1)$$

Thus, a functioning market has two desirable properties at the same time: it maximizes collective utility and it balances supply and demand.

### 5.2.3 Market failure: when markets don't function well

As a functioning market has such desirable properties, it's important to realize that the realization of these properties necessarily depends on valid preconditions. A failure in a sufficient precondition implies a market failure such that a market mechanism does not maximize collective utility or does not match supply with demand.

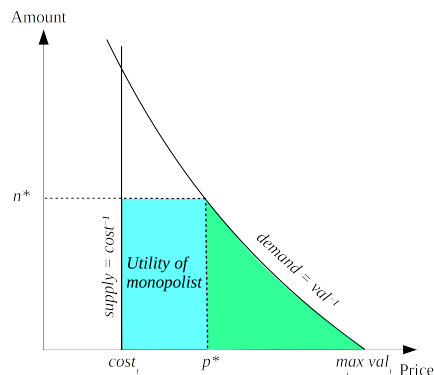


Figure 5.2: The *supply*- and *demand*-functions of a monopolistic market under the simplifying assumption that a monopolist can produce an arbitrary number of goods with identical cost per piece. The turquoise area represents the total utility of the monopolist, which the monopolist can maximize by setting the number of produced pieces.

A well known example of a market failure is a monopoly, where only a single seller exists that can produce any amount of a good to approximately constant piece costs. As shown in Fig. 5.2 such a monopolist can, by controlling the number of produced goods directly influence the realizable price in the market and thereby optimize its own total utility gained from all the trades.

Another well known example of a market failure concerns asymmetric information between Sellers and Buyers. George A. Akerlof, A. Michael Spence, and Joseph E. Stiglitz won the Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel in 2001 for their foundational work on markets with asymmetric information [LPW02].

A further, rather overlooked point for a market failure are hierarchical preferences. Money based decoupling of the acquisition of different goods necessarily implied their exchangeability in the sense that we were indifferent between different amounts of different commodities and some complementary amounts of money. There is no place for hierarchical preferences, where our valuation comes close to or even reaches all the money we have.

Just imagine, you get to know that you have acquired a deadly illness and you will die in, say, three months time. Now, someone tells you, yes, he (and only he) has the life-saving medicine just for you. Now, how much would it be "worth" to you? You will probably say, everything! In Germany, the pharmaceutical industry can unilaterally fix the price of a new drug in the first year. For new, so called "individualized therapies", the industry justifies prizes of up to a million € — not with its cost, but with the "utility" it creates for the individual patient [Rö18]. What would you think about a skipper in a boat in the middle of the ocean who discovers someone drifting in the sea, holding on to a plank and

starts rescuing the castaway only after bagging her complete assets? According to the presented money model, invoking the concept of utility here is simply an abuse of economic terminology to disguise plain plunder.

But we do not have to look at seemingly exotic situations. Because of the importance of health in comparison to death and most other commodities, it is to be expected, that in the healthcare sector market mechanisms often do not lead to efficient outcomes. And in fact, many studies show that countries that strongly advocate market mechanism in the healthcare industry, like the USA, spend a comparable much larger proportion of their GDP for healthcare without any demonstrable benefit. A recent investigation by Irene Papanicolas, Liana R. Woskie, and Ashish K. Jha [PWJ18] reiterates that the USA *"spent approximately twice as much as [10] other high-income countries on medical care, yet utilization rates in the United States were largely similar to those in other nations."* And, compared to these 10 other highest-income countries, the USA had the highest percentage of adults who were overweight or obese at 70.1%, the highest infant mortality with 5.8 deaths per 1000 live births, the lowest proportion with health insurance of 90%, the highest proportion of private health insurance with 55.3% and the lowest life expectancy with 78.8 years. What a poor outcome compared to the economic input!

Another example is the increasing production capacity of bio-fuel from all sorts of grain. Thereby the rich fuel consumers with their need for transportation and poor grain consumers with their need to eat become competitors (for a recent study, see [FJKZ17]).

The most important case of market failure, in my opinion, is due to unequal total budgets of the buyers and/or unequal access to all the relevant opportunities. If two Buyers, engaged in two different trades, don't have the same total budget and/or access to the same set of alternatives while deciding about their valuation, then yes, as stated already a couple of times, we can still formally add up their utility values to some sum but we lose the relation of this aggregate to their preferences. This sum will not contain this sort of information any longer, as it is destroyed by wealth-effects (see the Walrasian demand correspondence, e.g. [MCWG95], p. 23).

## Chapter 6

# Trading labour: the working human

### 6.1 A naive approach

Is selling ones labour the same as selling a book – or sugar? The economists of the 19th century said yes: a human could be simply viewed as an intermediate or trader: he transforms the goods for his reproduction he has to buy into his labour he can sell. For example, Karl Marx wrote in 1849, ([Mar49], p. 399):

Labour is therefore a commodity, no more, no less than sugar. The first is measured with a clock, the other with a scale.

And in his book "Das Kapital" ([Mar67], p. 185), he wrote:

The [exchange] value of labour is the value of the food necessary to maintain its owner.

So, adapting this point of view to our theory, as a seller of his labour, the employee's salary would be his revenue, his cost would be his expenses for reproduction, and the difference would be his utility.

But this view is seriously flawed, both on the revenue as well as on the cost side. First on the revenue side: in contrast to a book trade, which takes place in a logical second, the provisioning of human labour takes people a significant amount of their life time. And therefore for most of them its content matters more gravely. Usually, humans prefer one type of work over another one, depending on their preferences. Even if they prefer a certain job together with a salary of, let's say, 5.000€ per month over the same job with a salary of only 4.999€/month, they might prefer a second job with only 4.000€/month over the first job, even for 10.000€/month. There may even be jobs which some human would never take, not for any money in the world, due to hierarchical preferences. Obviously, in addition to selling its labour, a human can receive

something else to which its preferences relate to. This can be, to some extent, interchangeable against the received wage.

Secondly, the naive economic perspective is quite fuzzy on the cost side. What are the "cost of reproduction" for a human? Can we determine them as objectively as the costs of a company? Is it the money needed for heating, clothing, eating, and drinking only to prevent death? This would immediately raise the issue of hierarchical preferences. Or is it the cost necessary for "*social participation*"? In the German law, the level of social assistance is, according to §1(1) SGB XII, oriented at enabling the entitled people to lead a life in human dignity, concretizing §1 GG, that "*human dignity shall be inviolable*". This level is objectified by some commission, amenable to jurisdiction. Would this define utility as the money that is left over for leisure-activities? But what is leisure? Is, for example, having costly children enough rewarding to count as leisure? Or is it something else?

## 6.2 Recursive preferences

To sort things out, we have to reconsider what we wanted to express with money: our preferences. This is true for selling a book as well as for selling our labour. But there is an important difference: while we loose the book while selling it, we gain a job while selling our labour. So, from the perspective of our theory, Marx' assumption that we sell labour like we sell any other commodity is just wrong<sup>1</sup>. From an employee perspective, the indifference relation is between not having a particular job and no additional money beyond  $m_{total}^{Eee}$  and having this job and some additional minimal amount of money  $val_{job}^{Eee}$ . Thus, the "cost"-term of the labour-seller represents the minimal acceptable amount of money for which she would opt in favor of doing the job. In the language of mathematics we can therefore write:

$$\begin{aligned} (hasNoJob, m_{total}^{Eee}) &\sim (hasThisJob, m_{total}^{Eee} + val_{job}^{Eee}) \\ &< (hasThisJob, m_{total}^{Eee} + val_{job}^{Eee} + 1) \\ &< \dots \end{aligned}$$

I call this minimal amount of money also "valuation" as it expresses the valuation of the content of work by the employee. To distinguish it from the valuation of the employer, I speak of "external" valuation of the work in the case of the employer and of "inner" valuation in the case of an employee.

Actually, whether or how much our preferences influence our choice of job type is an empirically testable proposition and there is clear evidence for that. For a recent discussion of the trade off workers make between job characteristics

---

<sup>1</sup>This mistake makes Marx in my opinion to a somewhat tragic figure. Starting from a deeply rooted humanistic conviction, he pursued an economic theory based on completely inhuman principles.

for earnings, see for example [GB16, Fel12] and for an overview of work as a source of meaning see [CM18].

As with the valuation of the employee, we are not committing to the reasons, why an employee chose a particular amount, besides that his choice was not based on sheer necessity. It could be that he likes the job so much that he would do it virtually for nothing, or he likes the job very much, but knows about the high valuation of the employer and what his fellow employees receive, or that he dislikes the job and sees the salary as a indemnification, etc.

In contrast to trading ordinary goods, trading labour – in a free world – is therefore symmetric with respect to the discretionary component of employer and employee: the employer has a discretionary component resulting in some maximal amount of money she is willing to pay and the employee has a discretionary component resulting in some minimal amount of money for which he is willing to do the job.

$$\text{Employer: } \quad util_w^{Eer} = valExt_w^{Eer} - price_w^{Eer} \quad (6.1)$$

$$\text{Employee: } \quad util_w^{Eee} = price_w^{Eee} - valInt_w^{Eee} \quad (6.2)$$

$$\text{Total Utility: } \quad util_{w,total} = valExt_w^{Eer} - valInt_w^{Eee} \quad (6.3)$$

Actually, this model entails some interesting consequences. As for selling ordinary goods, the total utility can be influenced by both participants. The employer by creating a productive environment where it makes sense to pay an employee a lot of money — that sounds OK — and the employee by preferring this work so much, that he is willing to do the job almost for nothing, even negative sums are conceivable — that sounds strange. At first glance, it may seem that this inverse relation enforce an indemnification semantics on every salary where the salary has to compensate for all the scourges of the job. But caution! The valuation of the employee does only represent the lower boundary of the possible salary interval and not the salary itself. The following section shows that the situation can be quite complex.

### 6.3 Fair salaries

As in any other trade, the possible price range for labour could be substantial and the price, that is, the salary, is therefore subject to negotiation. Now, lets assume, that people have a hierarchically superordinated preference for fairness. What are the consequences?

If we view a company as something owned by some god-like patriach, providing completely directed "taylorized" relations of employment with predefined tasks for everyone that only have to be filled by some completely exchangeable employees, then it may seem fair to the owner to share the total utility generated by the company 1:1 with all his many employees – the second case of section 5.1. This means for arbitrary large companies arbitrary large shares for the owner. The share for the employees becomes their salary for them and costs for

the owner. His share becomes his profit. The question is for what purpose does the owner get all this utility gains from this company? If the owner withdraws his profit out of the company, then, according to our model, he will use it for possibly completely different, other purposes in other interactions. Possibly for private purposes - but even if he would put it in different businesses, this model is of questionable value, as doing successful Business *A* is probably only a weak indicator to become equally successful in another Business *B*.

If, in contrast, we view a company as a (legally) unowned person in itself that provides the jobs and is reciprocally shaped by its employees and that fulfills its destiny because of a collective effort, then we would conclude that its fruits should be partitioned equally with everyone who has put equal effort in it – the first case of section 5.1. Then, the generated utility would have to be divided equally among all its employees alike with no leftover because the money necessary for fulfilling the company’s economic purpose is already completely taken into account by its cost-terms. There is no money categorizeable as ”profit”. This draws our attention to companies as legal persons pursuing a given purpose with the autonomy of a real person and where thinking in the category of ”ownership” is actually inappropriate (see section 4.7.1). And this purpose cannot be ”maximizing profit” according to our money model, but must be something substantive, such as making the world happy with great cell phones.

But our assumed superordinated preference for fairness has an even more important consequence, as it renders the preference relations to become recursive<sup>2</sup>. Let us assume that an employer has to offer a job that she values at 130.000€. The employee with a superordinated preference for local fairness has an initial valuation of 10.000€. Thus, a fair salary according to the model of local fairness would result in a salary of 70.000€. But the employer offers the job for 20.000€ and the employee starts working. Now, he discovers, that the employer’s valuation is indeed 130.000€ and therefore a fair salary would have (initially) amounted to 70.000€.

What sum would this employee have to claim to remain in the company? If he claims 70.000€ as the minimal salary to stay in the company, he in fact relates to his own, older valuation of 10.000€ — which has just changed. So assuming 70.000€ as minimal acceptable salary, a fair salary would amount to 100.000, and so on and so forth. The preference relation becomes recursive. And the fixpoint is the valuation of the employer, in this case, 130.000€ and the utility of the labour trade becomes zero! As a result, the fairness notion of the employee fits exactly the valuation notion of the company, no conflict of interest occurs with respect to the general goal of remuneration (although a conflicting estimation of the valuation between employer and employee could persist). The utility of zero for the company just means that it does not employ people to make a monetary expressible profit but only to reach its business goal.

<sup>2</sup>According to my knowledge, recursive preferences were introduced to economics by David M. Kreps and Evan L. Porteus [KP78] and Larry Selden [Sel78] to distinguish the separate roles of time and risk. See also the work of Larry G. Epstein and Stanley E. Zin [EZ89] and Philippe Weil [Wei90].



Another recursive relation between the preferences of employer and employee might be created by a dependency of the external valuation of the employer on the internal valuation of the employee. The employer might expect that an employee who highly values doing a task will on average perform this task better than another one with lower internal valuation. In this case it would make sense for the employer (and it would be fair) if she pays employees with higher internal valuation more than employees with lower internal valuation - although the latter would possibly start working only for higher salaries.

## 6.4 Severance payments

In Germany, with its good protection against dismissal, we can empirically determine how much people value their current job compared to what they "really" want. Because of this protection we can, depending on additional circumstances like their expectations about the alternative to remain in a viable company, assume that the employees take their decisions for or against some severance package freely. With our theory we can then interpret the tendency to accept severance payments as an indicator for the strength of their preferences to work.

Let us assume that an employee earns a total future salary of  $m_{job}^{Eee}$  for the next  $n$  years until normal retirement. The risk of forced dismissal is assumed to be zero. Now, the employer wants to reduce its workforce and offers severance packages to convince employees to leave the company on a voluntary basis. Here the employee has to give up some money  $m_{renunciation}^{Eee}$  if he wants to quit. That is, the severance package equals the total future salary of the employee reduced by the waived amount:

$$severance = m_{job}^{Eee} - m_{renunciation}^{Eee}$$

Thus, the employee has to (freely) decide between the alternatives

$$(hasThisJob, m_{job}^{Eee}) \text{ versus } (canDoWhatHeReallyWants, severance)$$

Or, by subtracting on both sides the *severance*, equivalently

$$(hasThisJob, m_{renunciation}^{Eee}) \text{ versus } (canDoWhatHeReallyWants, 0)$$

If the employee accepts the severance package under these circumstances, the sum  $m_{renunciation}^{Eee}$  can be interpreted as a money-expressed lower bound for the dislike of the employee to do his job instead of what he "really" wanted to do. The more money the employee is willing to give up, the greater his dislike of his job.

The consequences of such programs for the company might be much more severe than getting rid of some employees and losing some money. While

an employer usually tries to attract employees with attractive conditions and salaries, she now in fact, puts money on the table to incentivize quitting and therefore improves her negotiation position by ruining the working conditions or threatening with future termination with worse conditions. In real life, things get more complex, as the employer then would have to convince the remaining rest of the workforce that this was not meant to be directed towards them. So it might be important for the company that the remaining rest of the employees, while not being directly involved, still values the offer of the company as being fair.

## 6.5 The consequences

Obviously, the most important consequence of the mutual discretionary component in trading labour is that, together with a hierarchical preference for fairness, the total utility function of the trade becomes recursive.

As a result, the clash of a patriarchic owner of a company with strong local fairness preferences with employees with the same attitude will create a strong conflict of interests. The conflict will be even larger if the owner is an adherent of the outdated theory of profit maximizing of the firm [JM76] and has the goal to minimize the salaries.

For an unowned (legal) person as an employer, with a superordinated preference for fairness and endowed with a given purpose, this conflict does not occur, as in this case it is natural to hand out the complete valuation of a job to an employee. Because the valuation of its workforce is exactly the money that remains after the company takes into account all its different cost of production, research, business development etc. What is left is the money it is able – and in this case also willing – to pay to the workforce as salary. Beyond that, there is no need for any left over to be additionally pulled out of the company for purposes completely unrelated to the business purpose.

Another important consequence of the recursive preference relation is that labour markets cannot work the same way as markets for ordinary goods which is already common sense in behavioural economics (e.g. [Doh14]).

## Chapter 7

# The private public money distribution (PPMD) problem

According to our theory, providing someone with a certain amount of money enables her to express her material preferences in all her trading interactions. As we have seen, the budget a person holds is key to understand how money makes subjective preferences interpersonally comparable – or incomparable. Providing someone with a comparatively larger or smaller budget results in an obvious stronger or weaker expressive power. Or, to put it a bit differently, if in a trade people with more budget put more money on the table, instead of expressing their stronger preferences, they perhaps just express that they have more budget.

Thus, per definition, if everybody has the same total budget and the same access to all relevant alternatives, then the money mechanism makes – per definition – the material preferences of different people comparable. So, depending on the fulfillment of these preconditions, the money mechanism achieves a little miracle, namely to objectify the entirely subjective perspective of our material preferences.

Thereby, our economic theory creates a strong tie to the moral theme of equality: Is it desirable to endow people with different or equal budget and therefore power to act according to their material preferences?

In my opinion the answer is indeed rather complex because our discussion must address at least these three questions: who owns the money from a legal perspective, who has the (real) power of disposition and who is affected by the effects.

Usually we attribute the private/public-distinction from the legal perspective: everything I own belongs to me and ownership establishes the right to the power of disposition and makes my owned things private to me. Public goods either cannot be owned, like air, or are owned by some public organizations that themselves cannot be owned by some individual.

But I think that it makes sense to use this private/public-concept also to structure the answer to the other two questions.

Pondering about the power of disposition directs our attention to the preferences and expectations of the acting subjects that use their available money to change the state of the world. Our preferences could be selfish, valuating only ourselves or they could be otherish, valuating also other people. I call money that is intentionally spent for selfish vs. otherish purposes "intentionally private" vs. "intentionally public" money.

On the other hand, talking about the effects, we talk about how all of us are simultaneously affected by these changes and how we interpret them according to our preferences. If the new state of the world is only preferred by ourselves, then I call money whose use had this effect "effectively private" money and money that changes the state of the world such that the new state is preferred also by others "effectively public" money.

And finally I would like to point out that the private/public-distinction can be understood as a recursive concept. That is, we can understand "private" also with respect to well defined groups of people, like the people of a family or an organization. The latter is expressed in the juridical notion of a 'legal' person.

## 7.1 Equal or unequal power to express material preferences?

The idea that all humans are equal has a long philosophical tradition. Thomas Jefferson phrased it as "All men are created equal" in the preamble of the US Declaration of Independence in 1776. 172 years later, in 1948, the United Nations Universal Declaration of Human Rights states in its Art. 1, sentence 1, "All human beings are born free and equal in dignity and rights."

From this principle, democracies derive the political demand of "*one human, one vote*" to express individual political preferences. Now the question is, to what kind of money should we extend this political demand for equality? I think, two things are obvious: first, as the expressive power is based on our total budget, the political demand of equality must directly translates into the demand of equal total budget. Secondly, the demand can only be directed towards private money, that is to money that relates exclusively to our own preferences. So, we have to examine, whether we should demand equal budget for intentionally private money or equal budget for effectively private money? And we have to examine whether we should pose what kind of other restrictions for the use of public money.

Using money effectively private is obviously not the same as to use it intentionally private, that is, to express egoistic preferences. It is certainly possible to change the state of the world from an exclusively egoistic perspective were this change nevertheless may be important also to other people. Conversely, the satisfaction of individual needs, of which we initially assume a certain equality from an ethical perspective, can have a very different private or public character: although my desire to eat, drink and house, etc. are not more important or more precious than the desire of any other fellow human, they are possibly

not exclusively private. For example, a mother who eats properly also acts in the interest of her child. The same is true for any loved one from the viewer's point of view.

I think one principle should be that there is no reason to put someone in a position to have more power than others to change the world's state in a way that only he finds the new state more preferable than the previous one. Thus, if we adhere to the moral principle of equality, we must demand, that within the realm of economics everybody to have the same budget of effectively private money.

It is actually not so easy to change the state of the world with money in purely private terms in this sense. In a free trade this is the case when Buyer pays only Seller's cost, leaving Seller indifferent. For example, if I buy an apple for its production cost and eat it, it is just me who benefits from this trade. But, if I buy an apple for my little daughter for a price that is above its production cost and she eats it, it is her who benefits from this trade together with the apple seller who gains some utility and perhaps me, because I like my daughter to become satisfied.

But hold on – what happens, if I buy the apple for my valuation? Then it's me who remains indifferent after the trade and it's only Seller who benefits. Thus, although I spent my money, this money was private for Seller as the trade changed the state of the world such that only Seller benefit and nobody else. Here the magic of money shimmers through, as we can make others' money to work effectively private for us in our sense just by changing the price of the commodity.

Thus, Buyer's money of a trade cannot be partitioned into two parts, as utility does, one private part of Buyer and the rest. Instead, equalling Seller's cost, the whole money of the trade leaves Seller's preferences indifferent, that is, the money was effectively private money for Buyer. And equalling Buyer's valuation, the whole money of the trade leaves Buyer's preferences indifferent, that is, the money was – although it was spent by Buyer (!) – effectively private money of Seller.

Now the other case of effectively public money, where we use money such that the preferences of others are affected. Obviously, effectively public money is not only the money we use for public schools or public infrastructure, but, as said before, already in a simple trade our money we use as buyer affects the preference of another subject, which makes it effectively public.

What kind of principles can we derive for the use of public money? Here, we cannot derive any simple budget restriction rule for the individual. Instead it is sensible to demand that effectively public money should achieve a somewhat optimal allocation of commodities in the sense of all.

We could say that it does not make sense to name money in such a way, as this distinction between public and private is obviously not a property of the money as such, like the light absorption or the mass is a property of coins, but it depends on the context. But we agreed at the very beginning of the book that it makes sense to view something as X if it fulfills the necessary functionality to qualify as X. In my opinion, the example of public and private money does

not invalidate this conceptual approach to view our world, but just shows how dynamic and contextual – or, one could even say 'magic' – our world becomes, if we look at things from a functional perspective.

On the contrary, this functional view directs our attention to the function of the money mechanisms: we might be able to achieve our demands at least approximately by designing the money mechanism in a way that it functions as desired.

## 7.2 The relevance of the relation between our intentions and our effects

Now, we are facing the problem, that our moral imperative is directed towards limiting private effectiveness but what we can much more easily achieve is limiting the amount of money that someone can spend, that is the (private) power to dispose.

The relationship between our intentions, whether they are purely selfish or also directed towards others, and the effects of our economically relevant actions is only a loose one. "well intended" does not imply "well done" and people can do great things for others out of purely egoistic motives. In fact, in a free trade, even purely egoistically motivated subjects will usually have to partition their utility with the other participant. This does certainly not imply that economic mechanisms aggregate purely egoistic preferences easily into universal prosperity. And it does also not imply that our intentions are irrelevant. Quite contrarily, as the proverbs "Where there's a will there's a way" or "Faith can move mountains" illustrate, our intentions play an important role in our economically relevant acting. Our ability to perseveringly act according to our intentions despite the many imponderables and random nature of our environment is one of our greatest strengths. But we do know that people differ strongly in their ability or willingness to act in favour of others.

So, there is indeed a very good reason to provide different people different total budgets for these public purposes – and I think it is the only rational a priori reason to do so from a collective point of view. It's because we expect them to use it better for the good of the affected people than others. Nevertheless, we could think of additional reasons for a certain unequal power to express exclusively self-directed preferences, due to additional functions, money can fulfill. As money is a part of a complex system to regulate the social performance of the people, it also serves as an incentive, a recognition and a reputation instrument. So, it could be that even an egalitarian society accepts a certain inequality in this respect to allow for an effective respective social signaling within the society. But there may be other ways to achieve these goals.

From a philosophical point of view, it's interesting to note that the argument to distribute public money unevenly was that people differ in their social preferences and abilities and that they are in particular not entirely selfish.

### 7.3 The problem of positive feedback and the 1:n problem

If the number of people is  $n$  and everyone would freely and randomly trade with everyone else we would have a number of trades of the order  $O(n^2)$ , and, starting with a balanced initial budget distribution, we would possibly get a balanced steady state with a balanced in- and outflow of utility for everyone.

But as it turns out, we do not see this kind of economic networks in reality. Instead, we see a spontaneously forming topology of trade relations with pronounced star character, such that there are few nodes with very many trade relations and many nodes with comparable few trade relations. In other words, comparably few companies sell their products to comparably many consumers.

Let us assume we have a producer of mobiles. That this company produces mobiles is indeed in the sense of (almost) all, as almost everyone wants to have a mobile and draws quite some utility out of it. A typical network effect: the more people have a mobile, the greater their individual utility. Obviously, this company handles a lot of public money.

Now let us assume that this particular company does a slightly better job than all the other producers of mobiles. It would be desirable to put this producer of mobiles in a slightly better economic position compared to all the other producers, as she better knows how to produce mobiles. This is exactly what a market economy does: it enables this "best" producer of mobiles to get a relatively larger share of the total utility generated by mobiles than other producers. Using her know-how and the additional money, she could express her preferences for the necessary resources for production of her better mobiles a bit more powerful than her competitors. This seems to be a sensible mechanism: who else should get these resources?

But, what happens, if this effect becomes too strong? It's actually a positive feedback loop and as we know from control theory, positive feedback exacerbates the effects of small disturbances and causes system instability, far off any equilibrium. What if, for example, due to platform effects, the utility accumulation becomes so large, that this producer cannot, even under the most optimistic circumstances invest that much money into the production of ever better mobiles. This would certainly make no sense. Thus, with markets we install a positive feedback mechanism that is, to a certain degree, desirable, but has also some destabilizing aspects and therefore needs additional regulations providing stability and robustness.

Things become even worse, if we look at hierarchical preferences. Let us assume that we have a set of consumers with approximately equal total budget and a basic commodity which is absolutely essential for virtually every consumer like staple food or a life saving vaccine against a deadly disease. And we have Sellers that can produce this commodities at comparably similar low and approximately constant piece costs. Hierarchical consumer preferences then mean that the valuation of each consumer is close to its total budget. The left part of Fig. 7.1 shows the utility partition provided by a market mechanism unter

perfect competition on Sellers' side. The price will be close to the production costs and the utility gets distributed largely to the public. But what happens with a monopolist, that is, a market where Seller is in a 1:n position against all Buyers? The right side of Fig. 7.1 shows that, because a monopolist can control the amount of commodities available for trading, he can virtually suck up all utility available in the market<sup>1</sup>. And the money flow of these trades serve more or less only the interests of the monopolist and in the limit, all the money of all market participants becomes effectively private to him.

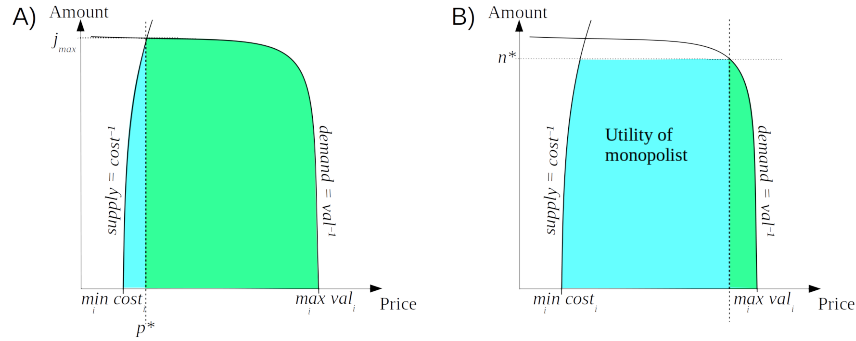


Figure 7.1: Part A) on the left side illustrates a market equilibrium of a basic commodity which is valued by all Buyers approximately equal. Part B) illustrates the same situation where a monopolist can determine the price via determination of the number of produced items  $n^*$ . The green area shows the total utility of all Buyers, and the turquoise area shows the total utility of all Sellers in A) and of the monopolistic Seller in B).

The 1:n problem and especially its monopolistic version shows that its the organizations as legal persons that matters and much less the single economic subject, because these organizations handle much more money. Monopolistic provisioning of basic goods with price determination by market mechanism is to be avoided.

## 7.4 The social intricacy of a world with money

Obviously, a world with money is socially rather intricate. To assess the social function of money, we have identified the criterion of our interpretation of the effects of money-based commodity reallocations based on our preferences – not only the preferences we can express with money, but all of our preferences, including hierarchical ones.

But we only can allocate money to people who will handle it according to their preferences and expectations. And whether we economically act with the

<sup>1</sup>Please note, that this example is just for illustrative purposes, as for Buyer's valuations that are close to her total budget, our model as such becomes invalid



intention to affect the preferences of others and whether and how we do affect the preferences of others is only loosely related.

We cannot differentiate between private and public money as we can differentiate between red and yellow flowers. Whether the money serves private or public purposes is not a property of the money itself but a question of its usage context. Additionally, the effective private vs. public character of money is not a hop-or-top case but more of a continuum. Our used money could benefit only me, me and someone else to different degrees, some other people, a lot of other people, etc. The benefit could become obvious immediately or only after a long time – or there could be even no benefit at all, but the opposite.

What's today reality? The economic inequality of humans in history and still today are just unimaginable. In a much-acclaimed 2014 report, entitled "Working for the few. Political capture and economic inequality" [FNG14], the independent emergency aid and development organization Oxfam reported that almost half of the world's wealth is now legally owned by just one percent of the population, the wealth of the one percent richest people in the world amounts to 110 trillion US\$ which is 65 times the total wealth of the bottom half of the world's population, and the richest 85 people in the world own the same as the bottom half of the world's population (for a current comprehensive survey of the development of the world's inequality, see also [ACP<sup>+</sup>18])

Even if we cannot logically conclude from this blatant dysbalance to some exact estimate of the distribution of effectively public budgets, just a brief, superficial look at the world suggests that it directly translates to an equally blatant dysbalance of the latter jeopardizing the efficiency of the money mechanism in a most fundamental sense. Today's inequalities in the distribution of private legal wealth do indicate that even those societies that currently view themselves as "modern" are indeed pretty archaic at least in the way they handle money — with all its devastating consequences. In Germany approximately 30% of wealth [CBW16], is just given to people without any track record of their ability to handle it in the sense of all, namely by bequest and donation [Bec04, ACP<sup>+</sup>18]. We even tolerate money distribution mechanisms distributing hundreds of millions of Euros or Dollars completely randomly to people having nothing more to show than a small slip of paper with some numbers on it and call that a "lottery". How weird is that?<sup>2</sup>

## 7.5 Towards a solution of the PPMD problem

A solution of the PPMD problem leverages the strengths of the money mechanisms and mitigates its risks. I view as a strength that under benign circumstances it can enforce even the greatest egoist to create utility also for others

---

<sup>2</sup>As some earlier reviewer has remarked, the style of this publication is generally quite formal. So, perhaps some reader might feel that an expression like "How weird is that" gives a "pamphlet" flavor to it. But in my opinion, expressing amazement or bewilderment is at the heart of any scientific thought. So, with this brief sentence I just express my irritation about this – at least from the point of view of my theory – unbelievable stupidity of a human society. (see also below)

in virtually all its actions. The large risk however is that it allows unequal effectively private budget allocation to an unimaginable extend.

We discussed a lot of methodological difficulties. They arise if we try to sort things out from a local perspective. If we give up our aim to find an exact solution but are satisfied with an approximate solution, a broad perspective suffices. The frame of the broad perspective is the social consensus that the function of money in the large is based on the fact that it really serves the interest of all and not just a few. Viewing the interest in which the money is spent as a key indicator we must state that the interests of different people are quite different. Some overlap very much, they can be disjoint, or they can even be opposite. Is money I spent for my education private or public money? Actually, society as a whole has a strong interest that people are well educated. And therefore this money has – in my opinion – a strong public aspect. Is money that we spend for our military in the public interest? If the military is used for aggression, it's obviously not, if it's used for purely defensive purposes, it's (to a large extend in my opinion) yes.

This shows that the question whether some money is private or to which degree it is public money, and whether it is wisely spent or not, is subject to discussion and possibly not even decidable in every case. Thus, the solution of the PPMD-problem has to be thought more of a societal discourse, as an everlasting, ongoing struggle to converge to a consensus. And this discourse will to a large extend be based on conjectures and generalized assumptions, why it will reach far into the realm of values and culture (see section 8).

As already touched at the end of section 7.1 we can hope to approximately solve the PPMD problem by designing the money mechanism in a way that it functions as desired. For example we have to prohibit monopolistic provisioning of vital basic commodities together with a price determination of a market (see section 7.3).

There are, indeed, a lot of societal developments which can be understood as a development in the direction of an intelligent solution of the PPMD-problem. One necessary requirement seems to be to separate the personal remuneration from the collective value that the person handles. If someone shows the ability to handle money wisely in the sense of all, she should not get more private money for herself, but more public money to handle it in the sense of all. This separation is very much supported by the juristical invention of an organization as a 'legal' person and the modern employment relationship, where according to the German Bundesarbeitsgericht [BAG03] an employee is only supposed to act as well as he can and does not owe the effect.

At least in the public sector of western-style democracies, this principle seems to be partially implemented. In Germany, the German Bundeskanzler(in) gets a salary 1.66 times larger than the highest civil servant salary B11 (BMinG, §11), which sums up to approx. 350.000€ a year. Compared to the yearly minimum salary category A2 of a federal civil servant of approx. 27.000€ this makes up a factor 13. In the German military, not really known to be the stronghold of egalitarianism, the factor between the income of the most simple soldier and a 4-star general is approximately 7-8.

Although these factors are still quite large, they are by far smaller than what we find in feudal structures or in contemporary large stock corporations, especially in the USA, and to a somewhat lesser extent in Germany. For example, Tim Cook, the CEO of Apple Inc. earned approximately 125 Mio US\$ a year [App], which makes, compared to the current minimum wage of 7.5US\$/h or approx. 13500US\$/year, rather an absurd factor of almost 10000! How weird is that?

Another important pillar to an intelligent solution of the PPMD problem seems to be the provisioning of basic commodities. Here supply always should outnumber demand, avoiding any monopolistic 1:n provisioning. For staple food, this has been achieved, but not, for example, for housing.

Often, companies are taxed differently from private persons and higher incomes are taxed over-proportionally — but rich people may find ways to evade these costs, especially by "economizing" it. Sometimes luxury goods are taxed higher than ordinary ones. Some countries distribute goods and services that are viewed as essential for the individual development, for example education, not by market mechanisms. Etc. But at the same time, and quite in contrast, the individual contribution to the financing of services like healthcare or pensions is often even capped.

What happens, if we do not "solve" the PPMD-problem? Money as a utility-distribution mechanism is a social tool with a lot of positive — but also negative potential. We cannot outwit the money mechanism. The degree to which a society uses money in the interest of all versus in the interest of a few cannot be hidden and should be quite obvious from a broad perspective.

What happens, if single individuals or small groups get into positions to handle a lot of public money in an area where they have no proven track record to act in the sense of all? A successful tennis world champion might be a disastrous business man, a somehow successful business man might be a catastrophic president or a super rich might prefer to invest billions of dollars into prestigious projects like sending a couple of people to Mars while hundreds of millions of poor people on earth have no education or even die because of such simple things as dirty water or senseless wars — although this might still be better than acquiring the next private island and the third private jet or yacht or whatsoever, things that will idle most of their lifetime.

With today's money mechanism, the global scale of trade makes is possible for individuals to accumulate "utility" on an incredible scale - ridiculing the very idea to express individual preferences on an equal basis with the devastating consequence of destabilizing our society. In my opinion, the current political system of the USA is a good example to demonstrate the severe consequences if people are allowed to influence public policy by almost limitless accumulated private money [Heb19].



## Chapter 8

# Money and morals

There is an obvious strong and ambivalent relation between money and morals. Lots of proverbs illustrate the negative side, like "Pecunia non olet", "money makes the world go round" or "it is easier for a camel to pass through the eye of a needle than for a rich man to enter the kingdom of God" (Bible, Matthew 19:24). But, there is also the experience that trade brings strangers together and there are many examples, where economic prosperity has also led to cultural flourishing, like Venice in the early Renaissance or Florence somewhat later.

Economics as a science is indeed build upon profoundly moral premises, most importantly the premise of truly free decisions, the dependence of any real existing money mechanism on its acceptance, our desire to implement a concrete money mechanism with certain desired properties, the win-win-character of a free trade, the discretionary component of humans offering their labour and our justification to distribute effectively private budgets equally and public budgets unequally. And there is a strong influence from the way we view money and use it back to our values and culture. There are famous works, investigating the mutual influence of culture and collective economic behaviour, like, for example, Max Weber's "Protestantische Ethik" [Web45], or Michio Mosihima "Why Japan has succeeded" [Mor82].

To provide two concrete examples: Armin Falk and Nora Szech [FS13] provide empirical evidence for a decay of moral values through market interaction. In the experiment, subjects decided between either saving the life of a mouse or receiving money. They found that under market mechanisms, the willingness to kill the mouse is substantially higher than in individual decisions. And in a multilateral market setting, prices for life deteriorate tremendously. Quite in contrast, Joseph Henrich et al. [HBB<sup>+</sup>05] provided strong empirical evidence that the more important exchange relationships are and the higher the benefits of cooperation in daily life become, the more prosocial behaviour occurs in a society.

I am convinced that one characteristic of modern societies is their requirement of a high degree of mental contextual differentiation of their people. They can behave selfishly in the context of a market and empathically in the context

of their family. They can behave cooperatively in the context of work and competitively in the context of a job advertisement. At the doctor's, they expose themselves without shame, and in public, they do not. Etc. But for this quality to fully unfold, it must be possible for the people to distinguish the contexts with sufficient certainty. And it must be clear that with their contextual adaptation of their behaviour, they still stick to their superordinated preferences, for example for fairness.

In this book I mostly looked at direct effects of money in trade interactions. But as shown, a trade is just a role-based description of an exchange relation between two complete subjects. Thus, holistically viewed, this exchange has many more effects, which I call "indirect" as a tribute to the initial focus of our attention, the trade. In my opinion the indirect effects are even more important than the direct ones. Although we can express only our material preferences in a trade, its effects also affect our hierarchical superordinated preferences. As I stated in section 4.8, we cannot buy peace, democracy, freedom, justice, etc. in a trade. But obviously, the way we handle money in trades is a strong determinant of these other things. Thus, from an economic perspective I would say that despite the outstanding significance of trade interactions for our society, the most important glue is of indirect nature: from an economic perspective we live in an "*indirect society*".

So, in the following I will elaborate more on the important relation between the way we handle money and its influence on our values and culture. It is my impression that especially the relation between values and culture and money is a good example for John M. Keynes claim that "*the ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else.*" ([Key64], p. 383), as the recipes we derive from our economic theories to shape our world essentially depend on the concepts we choose to understand it. So, I will also dwell on a couple of economic concepts directly related to money which are or have been quite influential in this respect, namely Pareto-efficiency, the role of egoism, rationality, and the addictive potential of money.

## 8.1 The indirect society: the mutual relation between values and culture and money

We know that money is in the best case about expressing our free material preferences in fair competition with others. What are values and culture about? Why must money and values and culture be tightly intertwined?

To understand how money works it does not suffice to think of single subjects to have preferences and expectations and therefore act accordingly. We have started our analysis with the picture of a huge interaction network where each subject is involved in many economic interactions. Thus, people interact with other people on a large scale and will therefore build up expectations about the other people's preferences and their expectations.

I view this network of mutual assumptions as our culture. Usually, expectations which are advantageous to one person will often be advantageous to other persons too. And because of its strong recursive nature, there will be only few stable states, creating the possibility for the individuals to act successfully with a few, quite general action heuristics [GHP11] despite all the imponderables. I call these action heuristics "values" in this sense that they represent simple rules how to successfully behave in a situation where we lack the detailed knowledge for a more elaborated behavioural strategy. To give some examples: knowing little about our social interaction partners and their expectations about our behaviour, we usually behave in a way we think they will recognize us as being polite. Knowing little about our future, we will usually put effort in reaching our goals. Knowing little about the effect of some change, we will usually be sceptical about applying this change to something we have done successfully in the past. Etc. Values can be contradictory and in this sense build a natural hierarchy as different values may prescribe different behaviours in the same situation and we then have to choose between them. For example, choosing between being polite and being honest towards a complete stranger, most of us would probably opt for being polite.

This conception of values is in line with the five features, Shalom H. Schwartz and Wolfgang Bilsky [SB87] identified as being common to most definitions of values in the literature. According to them, values are "*(a) concepts or beliefs, (b) about desirable end states or behaviours, (c) that transcend specific situations, (d) guide selection or evaluation of behaviour and events, and (e) are ordered by relative importance.*". Both authors also explored the tight relation between values and personality [BS94]. A more sociological perspective is taken by Steven Hitlin and Jane A. Piliavin [HP04], linking values with culture, social structure, and individual behaviour.

Taking a game theoretic perspective, Thomas Schelling [Sch80] introduced the idea to represent culture as a "focal factor", rooted in the expectations of people, rather than as a factor that affects individuals' preferences. Acknowledging that complex games usually have multiple equilibria, he argued that from a game theoretic point of view, anything in a game's environment or history that focuses the players' attention on one equilibrium may lead them to expect it, and so rationally "to play it". Roger B. Myerson [Mye09] understands Thomas Schelling's contribution as "*one of the most important ideas in social theory*" as it helps us "*to better understand the economic impact of culture*".

The central insight here is that values do not arise from the fact that all people are "the way they are", for example, honest or cooperative, and that a society's culture is not just some simple aggregation of the preferences of its people. But, depending on the context, an egoist, for example, may be of the (correct) conviction that it is better for him to behave cooperatively — just as an altruist may be of the (correct) conviction that it is necessary for his survival to behave egoistically. Instead, values are created by social mechanisms that make certain behaviours beneficial and sanction others [FS99].

The key work for me to illustrate the importance of the social group is that of Ernst Fehr and Klaus Schmidt [FS99, FS03]. Using a simple model, they

show how, under certain circumstances, on the one hand a small minority of egoists can make a large majority of reciprocal subjects to behave egoistically and, on the other hand, under other circumstances, a small minority of reciprocal subjects can make a large majority of egoists to behave cooperatively. These considerations direct our thoughts towards the decisive importance of the cultural context of economics.

It is empirically shown that societies differ enormously in terms of their values like, for example, fairness [HBB<sup>+</sup>05] and punishment [GHT05, HTG08] or free speech [sFR21]. Basically, the more important exchange relationships are and the higher the benefits of cooperation in daily life, the more prosocial behaviour seems to occur [HBB<sup>+</sup>05]. Economic activity seems to correlate positively with the values necessary for efficient trade. Thus, economic activity already has the tendency to make the world better, to make it more cooperative and people to behave more prosocial. How much stronger could this effect be, if we design it to fulfill its purpose really in the sense of all?

So, because money is about expressing an important part of our preferences and values and culture are about the collective effects of the mutual nature of our preferences, expectations and behaviour in our social interaction network, anything else than a tight connection between money and values and culture would be a big surprise. Or, to use the words of Karl Polanyi [Pol01]: "man's economy, as a rule, is submerged in his social relationships".

Viewing it more instrumentally, culture and values become a major mean to simplify complex societies in a world full of uncertainty. And I would even go so far as to say that the extent of social success we will have while acting according to values provides the upper limit of sustainable societal complexity. Consequentially, the culture of a society can be functional in the sense that it provides its people with sufficiently effective action heuristics/values or it could be dysfunctional, measured against the actual problems of the world a society has to collectively cope with.

What kind of values directly simplify a society's economy? I give a couple of examples in line with Roger B. Myerson's enumeration in [Mye09]: if we can walk into a store or a government agency where we have never been before and, knowing only little about it, we will do much better assuming that we are treated equally to everyone else rather than assuming the contrary. Or, if we can conclude a contract and, knowing only little of the contracting parties, do much better assuming that all contracting parties will abide by it. Or, if we buy a book today by partitioning our budget, knowing little about our future needs and wants, and do much better assuming that the rest of the money will be just as useful tomorrow. Or, if we put effort in something like our education today, we, knowing only little about the future, will do much better assuming that this will pay off somehow even in 20 or 30 years from now. Etc. If these kind of values were not valid, we would have to put a lot of effort in probably futile attempts of case-by-case decisions.

The role of culture and values for a modern society could be studied lastly quite vividly in the US: according to my impression, with Donald Trump becoming US-president, people, who formerly deeply believed that you better be



decent, respectful, upright, open minded and committed to become – according to their own measures – successful somewhere later in life, had to revise this view, as the Trump campaign empirically demonstrated that people who apparently lie, degrade their fellow humans, behave ruthlessly and narcissistically could do at least as well in their society. As values become part of our personality in the course of our development, the insight into the necessity to revise these values may elicit a strong feeling of insecurity and a shaking of one’s own soul life.

For a society, the risk of destroying values necessary for cooperation is that this can render the same society, which was quite simple and manageable yesterday, to become – almost overnight – extremely complex and in fact unmanageable tomorrow.

This understanding of values and culture implies that we somehow collectively decide in which kind of social world we want to live in. We can shape it such that – knowing little – we can be confident that effort, kindness and decency will usually pay off for us. Or we can willingly or unwillingly shape it such that strangers have to be deeply distrusted, we always have to sit with our back to a wall and we might never be sure not to say the right things to the wrong people.

This understanding of values and culture also makes it comprehensible, why it is highly unlikely to change our social world in a way many religions have tried with little success, namely by simply appealing to the good in the people, and also that it is conceptually impossible to establish a culture of decency and respect with means of lies and degradation. Instead, to enforce a desired culture, we have to enforce rules of the game such that the desired default behaviour truly pays off for the vast majority of the people in the long run.

In summary, the relationship between money and culture is deeply mutual. Money has a strong potential to influence our values and culture in one way or another. But to unfold its economic potential in the sense of all, money depends on a stable culture of trust and the stability of a culture of trust depends on the kind of function, money fulfills. In essence, any functioning large scale monetary system strongly depends on a stable value-oriented societal context and must therefore be designed to support it and not to destabilize it.

In fact, I view the way how our view and use of money influence our values and culture as an empirically verifiable evidence for the validity of our theory. According to our theory, money should exert a negative influence on our values and culture if we collectively abuse it by viewing it as a means of its own, if we try to express hierarchical preferences, or if we distribute effectively private money too unevenly and effectively public money not wise enough. And it should exert a positive influence on our values and culture if we use it in the sense of the presented theory indeed as a social coordination mechanism to fairly express our free material preferences. And it should also exert a positive influence if we use it to finance social mechanism that effectively encourage desired and discourage undesired behaviours.

## 8.2 Pareto-efficiency

Vilfredo F. Pareto (1848-1923) was the first to make the distinction between ordinal and cardinal utility and introduced the idea to handle the analysis of economic equilibria with ordinal utility [Asp01]. Honouring his achievements, a feasible allocation of resources is nowadays said to be "*Pareto-efficient*", if no other such allocation exists, that makes some consumer better off without making some other consumer worse off (e.g. [MCWG95], p. 313).

It is well known that Pareto-efficiency does not insure that an allocation is in any sense equitable, but has a strong tendency to justify the distributive status quo. Just assume we have, by chance, a very unequal wealth distribution, with a single super rich and a bunch of desperately poor. Any redistribution of wealth would be "Pareto-inefficient", because at least the super rich would be worse off. — So what?

Nevertheless, this concept of "optimality" plays an important role in the economic literature in distribution theory. Why? Why did this concept gain so much acceptance? One could argue that this concept is the lowest common denominator. If there is a situation in which one person can be better off without making the others worse off, this should be exploited.

But my impression is quite in line with Amartya Sen [Sen08], that the wide acceptance of the Pareto criterium was a direct consequence of the denial of the possibility to interpersonally compare utilities. By using the Pareto criterion, economists could evade this problem altogether and "solve" equilibrium problems without looking for interpersonal comparison of utility.

The denial of the possibility to interpersonally compare utility made economics a doctrine to justify the economic status quo. It enabled economists to skip over the question under which conditions the various utility functions of the different participants become comparable. And it removed the issue of social justice from the economic agenda, culminating in Friedrich Hayek's strange view of social justice being a "strictly empty and meaningless" ([Hay76], p. 68) concept.

Thus, it seems to me that many economists wanted to have their cake and eat it. On the one hand they treat money as if it makes utility comparable, on the other hand they use a theory to conceptualize its mechanisms that refrains from relying on this assumption — and, even worse, justifies the status quo with its enormous inefficiencies.

That "Pareto-efficiency" is likewise a bad model for human decision making is also well known and can easily be demonstrated with the example of the Prisoners' Dilemma. It represents a decision situation where two subjects have to decide independently between two alternative outcomes where both are better off if they behave cooperatively, but each one is even better off if one deviates unilaterally at the cost of the other one but both are worst off if both deviate together. As Roger B. Myerson says, it is an accepted simple illustration of how people's rational pursuit of their individual best interests can lead to outcomes that are bad for all of them ([Mye91], p. 98).

Usually this dilemma is illustrated by a story like that (taken from [Mye91]):

	B remains silent	B confesses
A remains silent	1 year , 1 year	6 years, 0 years
A confesses	0 years, 6 years	5 years, 5 years

Table 8.1: Strategic form of the Prisoners' Dilemma game. The table displays the number of years of imprisonment, depending on the individual decision to remain silent or to confess.

*"The two players are accused of conspiring in two crimes, one minor crime for which their guilt can be proved without any confession, and one major crime for which they can be convicted only if at least one confesses. The prosecutor promises that, if exactly one confesses, the confessor will go free now but the other will go to jail for 6 years. If both confess, then they both go to jail for 5 years. If neither confesses then they will both go to jail for only 1 year."* I show the number of years of imprisonment, depending on the individual decision in Tab. 8.1.

Analysing this game in terms of Nash-equilibria means to look for a strategy where no player could increase her expected payoff by unilateral deviation. Obviously, assuming that both player have chosen to remain silent, either of them would increase her payoff by confessing instead. So, the only Nash-equilibrium of this game is for both players to confess, despite their (much) higher payoff if they both remained silent – the exact reason why we view this situation as a dilemma.

Now lets turn to the criterion of *"Pareto-efficiency"*: here, an outcome is named *"Pareto-efficient"* if for all other outcomes at least one player is worse off. Here, the outcome resulting from (confess, confess) is the only outcome of the game that is *not* Pareto-efficient – the opposite result of the Nash-approach.

So, as Pareto-efficiency is an invalid model for natural human decision making, it's not a big surprise that it doesn't make much sense to use it to model economic equilibrium outcomes, which ultimately result form aggregated human decisions.

### 8.3 Egoism and beyond

According to Joseph Persky [Per95], the model of the economic subject as "the economic man" or "homo economicus" is generally traced back to John S. Mill, although he never used this designation in his own writing. In his consideration of what makes "political economy" a science [Mil36], John S. Mill proposed to abstract from *"the whole conduct of a man in society"* but to view him *"solely as a being who desires to possess wealth, and who is capable of judging of the comparative efficacy of means for obtaining that end."* But interestingly he qualifies his strong statement to entirely abstract *"of every other human passion or motive"* in the same sentence with the *"perpetually antagonizing principles to the desire of wealth, namely, aversion to labour, and desire of the present*

*enjoyment of cosily indulgences”, as they “accompany it always as a drag, or impediment, and are therefore inseparably mixed up in the consideration of it.”*

Viewed in the context of our theory, John S. Mill seems to equate wealth with accumulating “utility” in the traditional sense. Thereby he is led to a concept which makes the first consequence of our money model, that we always prefer to have more rather than less money, virtually the basis of man’s economic model - but he completely ignored the other consequence, that money should leave all our other preferences invariant. And he seemed to know intuitively that the “price” that people, whose preferences become so much dominated by money, have to invariantly pay is a rather superficial lifestyle.

Today, the model of the “economic man” or “homo economicus” is usually understood as a model of the economic subject, having a consistent preference relation towards the world such that it can be expressed as utility and can be maximized. As we have seen, this is not the same as John S. Mill’s idea. Often, this model is combined with the additional assumption of being entirely egoistic by exclusively pursuing the material self-interest.

As we have extensively discussed, the first assumption of treating our preferences as utility is valid insofar as its prerequisites apply. What about the second assumption of being entirely egoistic? First, it is important to note that it is a truly additional assumption and by no means included in the first one. Instead it is part of a simplifying model of the content of our preferences, which can be helpful and valid – but which is, again, tightly bound on prerequisites that have to be fulfilled.

The assumption of being entirely egoistic simplifies our consideration of the economic subject substantially as it isolates it socially. An egoist simply ignores the others in its preferences. It is an approach to simplify our economic theory, comparable to the ideal gas concept of physics, which in the simplest case ignores all interactions between gas molecules assumed to be point-like. In physics, this is a valuable model which explains, for example, the surprising fact of a lower temperature limit, as the gas’ volume would vanish at this temperature completely. And the model of the ideal gas describes the behaviour of real gases quite well as long as its preconditions hold – and therefore it does not explain why gases become liquids or even solids and many other phenomena.

The same holds for the social isolation assumption of egoistic behaviour. Meanwhile, it is empirically well established that people have quite different social preferences [FF02]. In a representative study in Germany, Thomas Dohmen et al. [DFHS08], for example, determined the distribution of the willingness to trust as well as positive and negative reciprocity. They found that most people state reciprocal inclinations, in particular in terms of positive reciprocity, as well as substantial heterogeneity in the degree of trust and reciprocity.

The question is, whether and how these more sophisticated social preferences become effective in economic contexts. The whole realm of behavioural economics as developed by Richard Thaler, Daniel Kahneman and others (e.g. [Tha15]) shows that there are very many important economic phenomena which cannot be explained satisfactorily by neglecting the social preferences of the economic subjects.

In the following I sketch pars pro toto three prominent examples, namely that of crime and punishment, the incompleteness of contracts, and the so called "pay-for-performance", where the attempts to apply the model of the egoistic homo economicus did fail entirely, partly with disastrous consequences for all of us.

### 8.3.1 Crime and Punishment

The economist Gary S. Becker received the 1992 Nobel Memorial Prize in Economic Sciences for his pioneering application of economic concepts to many rather sociological phenomena of human behaviour like discrimination, addiction, household economics, or viewing employees as a sort of "human" capital.

In 1968 he pursued the question how many resources and how much punishment should be used to enforce different kinds of legislation [Bec68]. Based on the model of the egoistic homo economicus, a price model of the supply and demand for offenses led him to the proposition that an optimal punishment system would combine low costs for the public (resulting in low probability of being punished) with a high level of punishment for the individual if caught. But this conclusion was "*quite at odds with what we observe in the real world*", as Steven D. Levitt noted [Lev17].

That economical reasoning about offences will be complex can be seen at the different inprison rates of men and women, which in Germany in 2018<sup>1</sup> was 48026 men versus 2931 women, or 94,2%:5,8%! Criminal behaviour is by and large male. Why? As Richard B. Freeman said in 1999 [Fre99]: "*No economist has tried to explain the greater participation of men than women in crime in terms of incentives.*". Even Cass R. Sunstein, Christine Jolls and Richard H. Thaler in their behavioural approach to law and economics don't go into that issue [SJT98].

### 8.3.2 Pay-for-Performance

Based on the assumption of purely egoistic economic subjects, Michael C. Jensen and William H. Meckling demanded in 1976, for owned companies to establish incentive compensation systems which serve to more closely identify the manager's interests with those of the outside equity holders [JM76] – which they assumed to maximize exclusively their return on invest.

Today, we know that direct incentives do work all too well, but only as implemented and not as possibly intended. They result in canibalization of hard by easy tasks, misalignment, manipulations, etc. There is a whole bunch of economic scandals which can be directly linked to dysfunctional incentive schemas, the most prominent probably the banking crisis 2008/9 [BCS10, BB13] with public costs of at least 68 Mrd€ for the bank saving actions in Germany

---

<sup>1</sup>statistisches Bundesamt, Fachserie 10 Reihe 4.1, Strafvollzug - Demographische und kriminologische Merkmale der Strafgefangenen zum Stichtag 31.3.

alone<sup>2</sup>.

In his Nobel Prize Lecture, Bengt Holmström calls it "You Get What You Pay For". To explain the fact, that firms use pay-for-performance schemes rather sparingly, but use fixed pay instead, he names two arguments: performance measures within the firm is weaker than in the market. And due to the issues of multitasking, firms use "*many substitutes for pay-for-performance incentives that are not easily accessible through market contracting. Foremost among them is the ability to control work through job assignments, job designs and a variety of implicit and explicit rules that the firm sets.*"

### 8.3.3 Completeness of contracts

Analyzing the behaviour of egoistic subjects assigned a single tasks by some principal on the basis of a one-dimensional effort model, Bengt Holmström [Hol79] formulated in 1979 as "informative principle" the demand "*that any measure of performance that (on the margin) reveals information on the effort level chosen by the agent should be included in the compensation contract.*" [Pre99].

But the reality is that employment contracts are usually very incomplete and modern employment rests very much on trust. Especially higher qualified jobs usually consist of many interdependent tasks and therefore, any optimal design would need to consider the employee's incentives in totality [Hol]. In fact, Armin Falk and Michael Kosfeld provided strong evidence that under certain conditions of uncertainty it is (much) more efficient to provide employment relationships on the basis of trust than of control [FK04].

## 8.4 Rationality

It is common under economist to name the consistency property of the preference relation I discussed in section 3 "*rational*". I think this is an unfortunate misnomer as it suggest that the two properties of the preference relation, namely to be complete and transitive, provide an adequate concept of what we mean by "rational" in colloquial terms. In my opinion this is wrong due to at least two reasons.

First, as it is meanwhile also common sense among economists, it is completely irrational (in colloquial terms) to assume that we in general have this kind of "rational" preferences. While one could argue that our wishes and desires have to have a transitive structure to qualify for rationality in colloquial terms, even for the most rational subject, there is not the slightest chance and not even a need to have complete preferences but for very, very tiny sections of our world.

The second argument aims directly at the relationship between our goals and means. Restricting the concept of rationality to some properties of the prefer-

---

<sup>2</sup>according to an estimation of the Grüne party in 2018 based on a "kleine Anfrage" in the German parliament, <https://www.gruene-bundestag.de/finanzkrise/kosten-der-bankenrettung-mindestens-68-milliarden-euro.html>

ence relation implies a complete disconnect between our concept of rationality and the content of our wishes and desires. A sentence like "There are some wishes and desires that qualify as bizarre and rather irrational", which most people would say they comprehend, would actually make no sense.

It is my impression that the inadequate usage of the term "rational" in economics is ultimately based on the ignorance of the interactional nature of the exchange relationship. One could certainly write a book of its own about this topic, especially to pay tribute to the many people who have contributed groundbreaking ideas here. However, since I am only interested in substantiating my claim, I will just outline the rough train of thought.

There is one phenomenon whose understanding of its origin is, in my opinion, absolutely essential for our further discussion: our language. I understand natural language as a facilitation mechanism for inter-subjective or social interactions. In this sense it is a pragmatic solution to the circular or "chicken-or-the-egg"-problem that on the one hand a purposeful interaction requires mutual understanding and establishing a common context of interpretation and on the other hand establishing mutual understanding and a common context of interpretation requires purposeful interaction [Rei20b].

Understood this way, it is obvious that to learn a first language we must be able to put ourselves in somebody's position, to empathize. Thus, emotions and understanding are not independent in the sense that understanding is free of all emotions, but emotions are part of our understanding in the sense that they modulate it. We understand differently if we are angry, suspicious, friendly, sympathetic, etc. And therefore, to reach mutual understanding in a language learning environment, it is essential, that we show our emotions, that is, our mode of interpretation to our interaction partners.

Modulating our understanding doesn't mean to change it completely which implies that we can abstract certain rules which have to be followed under almost all modes of understanding to remain intelligible by our interaction partners, for example the rules of logic. There are indeed interesting approaches to derive the rules of logic from interactions [LL78, HS79]. So in this line of thought, the relation between a clear and prosaic "understanding" (in German "Verstand") and our emotionally modulated, concrete understanding is an abstraction. Thus, it makes sense to think that we can indeed understand virtually every human, as long as we can put ourselves in its position.

The alleged neutrality regarding the content of our wishes and desires thereby would prevent us from adequately understanding the obvious relation between our understanding and our emotions, as I had already indicated in section 3.3. And this relation is of obvious economic importance as not least the success of the advertising industry shows.

Rationality in the sense of the German "Vernunft" relates to statements like: it is rational "to do what you want most" or "to assume that all human are equal" or ([Kan88]) "to act only according to that maxim whereby you can, at the same time, wish it to become a universal law.". These statements are all comprehensible but as the centuries-long debate shows, none of them is compellingly convincing to all people. And this is quite plausible, as all of them

somehow relate to some debateable premises.

To conclude from this that it would therefore be reasonable to relate the concept of rationality solely to the consistency of our preferences and assumptions with our decisions, would be to throw the baby out with the bath water. The much better conclusion, in my opinion, is, that though consistency in the sense of an inference from our preferences and assumptions to our decisions is an important aspect of our concept of rationality, we should not exclude the premises people hold from this concept. We simply cannot come to a sensible concept of rationality by abstracting from every preference and assumption. To give an example: we can possibly understand someone if he adheres to the concept of a superhuman with extra rights above all others – but we can reject it for ourselves as unreasonable on the ground of our different premises.

I think it could be really interesting to investigate the question, why the term "rational" was established in economics in this sense for a simple property of a simple relation that other specialities would just have named "consistency". At least for me, it seems obvious that this narrow conception fits nicely to the view of economics being concerned only *"with that aspect of behaviour which arises from the scarcity of means to achieve given ends."* – a quote of Lionell Robins in 1932 [Rob32] (p. 23). This was the time, where economists almost exclusively reduced the explanation of human behaviour to simple minimization or maximization problems aiming either at achieving maximum utility with existing resources or reaching a specific goal with minimum effort. It was the age of positivism, where philosophers seriously thought that is was unscientific to think that something meaningful could be said in ambiguous terms [Wit21] and it was the time of behaviourism, where psychologists thought it being unscientific to attribute a free will and an inner mental life to humans and tried to explain all human behaviour by simple reflex schemata [Ski53]. From today's perspective it is truly astonishing what not just a few cranks but really generations of serious scholars thought of being scientific vs. unscientific – an astonishment that should instil a little humility in us.

## 8.5 The addictive potential of money as a reward

As shown, money can play an important role in externally supporting our autonomy by creating personal freedom or impede our autonomy by creating economic compulsions just by working in its economically intended way. However, it can do so also from a mental perspective.

In section 4.5, I mentioned two simple but important consequences of how money, working in the sense of our theory, implants itself into our preferences: First, money should have no influence on our preference relation of other goods and second, it is always preferable to have more than less money.

Both assertions relate directly to our preference relation and therefore to our mental state. Now, are both assertions empirically true or violated? The first would mean that our preferences are independent on the amount of money we have. This seems to be valid in a pretty wide range of wealth distribu-



tion, although researchers have found important exceptions, for example (quite unsurprising) with respect to estate taxes and redistribution [DGG06].

If the second would be true under all circumstances, then why do some, often intelligent people intentionally prefer a life in privation? For example, why did Ludwig Wittgenstein give away most of his fortune to his siblings? Probably because they intuitively see money in its current form as a distractor, or even a means in itself, a "fetish" in Marx' terminology and want to avoid being distracted from their main focus of interest.

It is interesting to note that any economics, which views as the essence of all economic doing to maximize ones monetary measurable profit in the sense of the economic man of John S. Mill, renders itself artificially blind against any undue influence of money on our preferences.

Indeed, there is a well known mechanism, where money taints our preferences and starts getting a fetish semantics, namely when we use money as a *reward*. In psychology, a reward is defined as an external stimulus that is supposed to reinforce an otherwise spontaneously occurring behaviour in simple learning situations, called classical (Pavlovian) and operant conditioning<sup>3</sup>. Newer research shows, that it is the discrepancy ("prediction error") between the reinforcer that is predicted based on a stimulus and the actual reinforcer which determines the learning by reward [WDS01, ODF<sup>+</sup>03].

Its effectiveness for learning is bound to a certain degree of freedom necessitating the internal construction of the prediction model. It entails a strong tendency to shift the motivation to act from internal sources to the reward as an external source [DR00], which is, by definition, a change in what we want.

Scientists have identified the neural subsystem concerned with this type of learning and call it the *reward system* [Sch15]. It is a core part of our complex autoregulation system providing us with our autonomy, why I find the term "autoregulation system" more appropriate. As a consequence, artificially disturbing this system, for example with drugs [Sch11], can have disastrous consequences for our ability to act autonomously – and it makes little sense to assume stable preferences even in strong addiction as for example [BM88]. Drug addiction is indeed one of the major reasons for autonomy disorders by interfering dramatically with our preferences. The WHO defines the "dependency syndrome (F1x.2)", in its current ICD-10 catalog [O<sup>+</sup>19] by requiring at least three of the following symptoms to be present together at some time during a year:

- (a) a strong desire or sense of compulsion to take the substance;
- (b) difficulties in controlling substance-taking behaviour in terms of its onset, termination, or levels of use;
- (c) a physiological withdrawal state . . . ;
- (d) evidence of tolerance . . . ;

---

<sup>3</sup>In contrast to a reward, I view a "*recognition*" as an externally provided confirmation of the veracity of a subject's behaviour and thereby a reinforcement of the subject's internal source of motivation.

- (e) progressive neglect of alternative pleasures or interests because of psychoactive substance use, increased amount of time necessary to obtain or take the substance or to recover from its effects;
- (f) persisting with substance use despite clear evidence of overtly harmful consequences . . . .

While drugs directly interfere with the autoregulation system from inside, other form of addictions demonstrate that the autoregulation system itself exhibits a certain plasticity and can also be destabilized from outside. It seems that extensive rewarding does in itself change the autoregulation system, especially in childhood and adolescence. This is the reason why in virtually every good book on child education, the authors warn about the undesirable effects of rewards in education, for example, Remo Largo, a well known pediatrician says: "rewards keep a child dependent and prevent it from developing personal responsibility" ([Lar99], p. 341).

Due to its versatile nature, money is excellently suited as a reward. In fact, based on management literature like [JM90] and the improper semantic equating of incentives and rewards, the current salary systems of managers has accumulated lots of elements with a clearly intended reward semantics: the higher the management level, the more comprehensive. Thereby, it seems that in the sense of Sumantra Ghoshal [Gho05] that "Bad Management Theories are Destroying Good Management Practices" our current society puts the people it entrusts with most of its public money, its company managers, into remuneration regimes which foster dependent and irresponsible behaviour. In fact, the strange idea to "reward" employees for doing their job is nowadays so ubiquitous, that companies name their remuneration departments occasionally "total rewards". Even Michael C. Jensen draws the comparison to dependence in *The Economist* (14th Nov. 2002): "In the bubble, the carrots (options) became managerial heroin, encouraging a focus on short term prices with destructive long-term consequences.". All this lead Bruno S. Frey and Margit Osterloh to request that "managers should be paid like bureaucrat" [FO05].

Distinguishing between money to express our undisturbed preferences and money to express money-stained preferences, where money has become an end in itself, we have again two different, difficult to distinguish sorts of money which reminds me in some sense to Karl Marx' distinction between capital and money.

Actually, I find the strong tie between our system of autoregulation and money an empirical proof that our model of the mind captures indeed validly important parts of our mind. As any autoregulation system should first and foremost strive to guarantee our autonomy including our freedom of decision, it turns out, that with our preference concept to "explain" our free decisions, we in fact described some important parts of our system of autoregulation per construction.

One problem with the destabilization of our system of autoregulation with money is that it is systemically hard to detect, as the preference to accumulate more and more money is also part of the money model. So in contrast to all other addiction-induced activity narrowing, the personal compulsion to accumulate

money usually does not lead into economic poverty reducing the evidence of "overtly harmful consequences". However, this does not mean that it is not detectable, as a sense of compulsion or a progressive neglect of alternative – non-monetary valuable – pleasures or interests, especially in social terms might still be obvious.

Indeed, I think with the first assertion, that money should not interfere with our other material preferences at all, we have a rather sensitive instrument to determine, whether money starts to undesiredly influence our autoregulation system and thereby starts to taint our preferences or not.

In summary, we must distinguish between desired and undesired effects of money on our preferences. The desired effects are our two derived properties. But for some people money can and does exert an additional, undesired influence on their preferences which might range from slight taintness to full blown addiction. Thus, there is a normative humanistic aspect of the delineated money model to request a social environment that supports the unfolding of our preferences during our mental development undisturbed by any undesired money semantics. A simple step in this direction would be to avoid, or even legally ban all remuneration with too much of a reward character. And this should also be effective for responsible positions handling larger amounts of public money – as we do it with other forms of remuneration with clearly identified strong undesired effects, like bribery and corruption.

## 8.6 A brief imagination on money distribution mechanisms

There are a lot of issues I did not discuss at all, among the most important are the money distribution mechanisms. Nowadays we live in a world of material flows and money cycles. Meanwhile it is a global consensus that our economy should be based on material cycles. Do we know for sure that we can achieve that with the current circular money system? Currently, money is mostly created by the peripheral banks lending more money than they nominally have to deposit at the central bank as security. They lend it and get it somehow back in the future – an apparent circle, only broken by fraud and bankruptcy. It is distributed to the people mainly by the companies and the state against their effort and thereby serves as an important incentive mechanism to contribute to society.

This system rests on accumulating more and more debt and relies on its evenly distribution — without any systematic stability guarantee. What happens if these debts concentrate too much, could be studied during the financial crisis 2008/2009. So, perhaps this setting becomes even more unstable if we impose truly material cycles?

Perhaps we should live in a world of material cycles and money flows? A money distribution system with broadly distributed money sources and sinks would probably be much easier to stabilize. Sources could be a basic income, not necessarily unconditional, but still paid according to some effort measure.

Sinks could be provided by a transaction tax — whereby the taxed money would not go somewhere else, like to the state, but would just vanish. Such a mechanism would instill "friction" into the system and would make steering the money flow velocity easy.

## Chapter 9

# Concluding remark

Money works not "as it is" but it works the way we use it, governed by the rules we implement. We cannot outwit the money mechanism by using it in some way A and position it to have another meaning B. This simple insight bears chances and risks. This book's aim was to show that carefully designed, money can strongly support our autonomy and thus be a strong pillar for an egalitarian society. But under different circumstances it can also be a source of incredible sorrow and grief that drags us all into the abyss.

In my opinion economics should guide us to leverage the chances and avoid the risks of the money mechanism. Therefore economics is a normative science with a strong mutual tie towards morals or ethics. It rests on the assumption of free decisions and genuine preferences, it rests on the fact that money only works because we prefer it to do so, it reminds us that we do not provide our life time as labour in the same way as we sell commodities like sugar, and that accumulating wealth depends on a sustaining, stable social context. And therefore economics should guide us to sustain and extend its own base of validity. In fact, to derive the possible function of money as a social coordination mechanism to express our free material preferences under fair consideration of all the other people's free material preferences, we used our freedom of choice to choose a certain utility representation for our preferences.

By understanding money as a social coordination mechanism for distributional fairness we take a step towards true social progress – only to understand that implementing it as such creates a bunch of difficult new problems: our preferences are notoriously inconsistent, money tends to accumulate spontaneously, money for public and private purposes cannot be easily differentiated, money is used for other, conflicting purposes like reputation management at the same time, etc. So, sorting these things out will be a very interesting endeavour. It is up to us as a society to decide which world we want to live in and to attribute money its desired meaning.



# Bibliography

- [ACP+18] Facundo Alvaredo, Lucas Chancel, Thomas Piketty, Emmanuel Saez, and Gabriel Zucman. *World inequality report 2018*. Belknap Press, 2018.
- [All53] Maurice Allais. Le comportement de l'homme rationnel devant le risque: Critique des postulats et axiomes de l'école américaine. *Econometrica: Journal of the Econometric Society*, pages 503–546, 1953.
- [App] Inc. Apple. Notice of 2020 Annual Meeting of Shareholders and Proxy Statement.
- [Ari12] Aristotle. *Politics, a Treatise on Government*. J M Dent & Sons Ltd., 1912. Translated by William Ellis; reprinted 1919,1923,1928; electronically available [www.gutenberg.org](http://www.gutenberg.org) as EBook #6762.
- [Ari09] Aristotle. *The Nicomachean Ethics*. Oxford University Press, 2009. Translated by David Ross.
- [Arr51] Kenneth Joseph Arrow. *Social choice and individual values*. New Haven, New York / London: J. Wiley / Chapman & Hall, 1951. Reprinted as: Arrow, Kenneth J. (1963). *Social choice and individual values* (2nd ed.). New Haven: Yale University Press.
- [Asp01] Patrik Aspers. Crossing the boundary of economics and sociology: The case of vilfredo pareto. *American Journal of Economics and Sociology*, 60(2):519–545, 2001.
- [BAG03] Bundesarbeitsgericht, Entscheidung vom 11.12.2003, 2 AZR 667/02, 2003.
- [BB13] Sanjai Bhagat and Brian J Bolton. Bank executive compensation and capital requirements reform. *Available at SSRN 1781318*, 2013.
- [BBK+78] Barry W Boehm, John R Brown, Hans Kaspar, Myron Lipow, McLeod G J, and Merrit M J. *Characteristics of software quality*. TRW Softw. Technol. North-Holland, Amsterdam, 1978.

- [BCS10] Lucian A Bebchuk, Alma Cohen, and Holger Spamann. The wages of failure: Executive compensation at Bear Stearns and Lehman 2000-2008. *Yale J. on Reg.*, 27:257, 2010.
- [Bec68] Gary S Becker. Crime and punishment: An economic approach. *The Journal of Political Economy*, 76(2):169–217, 1968.
- [Bec76] Gary S Becker. *The economic approach to human behavior*. University of Chicago press, 1976.
- [Bec96] Gary S Becker. *Accounting for tastes*. Harvard University Press, 1996.
- [Bec04] Jens Beckert. *Unverdientes Vermögen: Soziologie des Erbrechts*. Campus, Frankfurt a. M., 2004.
- [Bel61] Richard Ernest Bellman. *Adaptive Control Processes*. Princeton University Press, NJ., 1961.
- [Ber54] Daniel Bernoulli. Exposition of a New Theory on the Measurement of Risk. *Econometrica*, 22(1):22–36, 1954. Originally published as "Specimen Theoriae Novae de Mensura Sortis," Commentarii Academiae Scientiarum Imperialis Petropolitanae, Tomus V [Papers of the Imperial Academy of Sciences in Petersburg, Vol. V], 1738, pp. 175-192.
- [BGRS99] Kevin Beyer, Jonathan Goldstein, Raghu Ramakrishnan, and Uri Shaft. When is "nearest neighbor" meaningful? In *In Int. Conf. on Database Theory*, pages 217–235, 1999.
- [BH20] Oben K Bayrak and John D Hey. Understanding preference imprecision. *Journal of Economic Surveys*, 34(1):154–174, 2020.
- [BM33] Adolf Augustus Berle and Gardiner Coit Means. *The modern corporation and private property*. New York, The MacMillan Company, 1933. Newly published 1991 by Transaction Publishers.
- [BM88] Gary S Becker and Kevin M Murphy. A theory of rational addiction. *Journal of political Economy*, 96(4):675–700, 1988.
- [BMS20] Anna Bogomolnaia, Herve Moulin, and Richard Stong. Guarantees in fair division: general or monotone preferences. *preprint arXiv:1911.10009*, 2020.
- [BS94] Wolfgang Bilsky and Shalom H Schwartz. Values and personality. *European journal of personality*, 8(3):163–181, 1994.
- [CBW16] Giacomo G. Corneo, Timm Bönke, and Christian Westermeier. Erbschaft und Eigenleistung im Vermögen der Deutschen: eine Verteilungsanalyse. *Perspektiven der Wirtschaftspolitik*, 17(1):35–53, 2016.



- [CM12] Andreas Chai and Alessio Moneta. Back to Engel? Some evidence for the hierarchy of needs. *Journal of Evolutionary Economics*, 22(4):649–676, 2012.
- [CM18] Lea Cassar and Stephan Meier. Nonmonetary incentives and the implications of work as a source of meaning. *Journal of Economic Perspectives*, 32(3):215–38, 2018.
- [CNMS15] Robin P. Cubitt, Daniel Navarro-Martinez, and Chris Starmer. On preference imprecision. *Journal of Risk and Uncertainty*, 50:1–34, 2015.
- [Dav02] Glyn Davies. *A History of Money: From Ancient Times to the Present Day*. Cardiff: University of Wales Press, 3 edition, 2002. 1st edition published in 1994.
- [Deb54] Gerard Debreu. Representation of a preference ordering by a numerical function. *Decision processes*, 3:159–165, 1954.
- [DFHS08] Thomas Dohmen, Armin Falk, David Huffman, and Uwe Sunde. Representative trust and reciprocity: prevalence and determinants. *Economic Inquiry*, 46(1):84–90, 2008.
- [DGG06] Daniel Doherty, Alan S Gerber, and Donald P Green. Personal income and attitudes toward redistribution: A study of lottery winners. *Political Psychology*, 27(3):441–458, 2006.
- [Doh14] Thomas Dohmen. Behavioral labor economics: Advances and future directions. *Labour Economics*, 30:71–85, 2014.
- [DR00] E. L. Deci and R. M. Ryan. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55:68–78, 2000.
- [Dra94] Stavros A Drakopoulos. Hierarchical choice in economics. *Journal of Economic Surveys*, 8(2):133–153, 1994.
- [EFT96] H.-D. Ebbinghaus, J. Flum, and W. Thomas. *Einführung in die mathematische Logik*. Spektrum Akademischer Verlag GmbH, 4 edition, 1996.
- [Ell61] Daniel Ellsberg. Risk, ambiguity, and the savage axioms. *The quarterly journal of economics*, pages 643–669, 1961.
- [Eng95] Ernst Engel. *Die Lebenskosten belgischer Arbeiterfamilien früher und jetzt: ermittelt aus Familien-Haushaltrechnungen und vergleichend zusammengestellt*. C. Heinrich, Dresden, 1895.

- [EZ89] Larry G. Eppstein and Stanley E. Zinn. Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework. *Econometrica*, 57(4):937–969, 1989.
- [Far01] Berndt Farwer. Omega-Automata. In Erich Grädel, Wolfgang Thomas, and Thomas Wilke, editors, *Automata, Logics, and Infinite Games*, volume 2500 of *Lecture Notes in Computer Science*, pages 3–20. Springer, 2001.
- [Fec60] Gustav Theodor Fechner. *Elemente der Psychophysik, Erster Theil*. Breitkopf und Härtel, Leipzig, 1860. translated by Adler, H. E., Eds. Howes, D. H., Boring, E. G., published by Holt, Rinehart and Winston, New York, 1966 ).
- [Fel12] Christina Felfe. The willingness to pay for job amenities: Evidence from mothers’ return to work. *ILR Review*, 65(2):427–454, 2012.
- [FF02] Ernst Fehr and Urs Fischbacher. Why social preferences matter - the effect of non-selfish motives on competition, cooperation and incentives. *The Economic Journal*, 112:C1–33, 2002.
- [Fis91] Peter Clingerman Fishburn. Nontransitive preferences in decision theory. *Journal of risk and uncertainty*, 4(2):113–134, 1991.
- [FJKZ17] Ondrej Filip, Karel Janda, Ladislav Kristoufek, and David Zilberman. Food versus fuel: An updated and expanded evidence. *Energy Economics*, 2017.
- [FK04] Armin Falk and Michael Kosfeld. Distrust - the hidden cost of control. IEW - Working Papers iewwp193, Institute for Empirical Research in Economics - IEW, 2004.
- [FNG14] Ricardo Fuentes-Nieva and Nick Galasso. Working for the few. Political capture and economic inequality. Technical report, Oxfam, 2014.
- [FO05] Bruno S. Frey and Margit Osterloh. Yes, managers should be paid like bureaucrats. *Journal of Management Inquiry*, 14(1):96–111, 2005.
- [Fre23] Sigmund Freud. *Das Ich und das Es*. Internationaler Psychoanalytischer Verlag, Leipzig, 1923. Ebenso: Studienausgabe, Bd. 3. Psychologie des Unbewussten. Fischer Taschenbuch-Verlag, Frankfurt am Main 2000, ISBN 3-596-50360-4, S. 273–330.
- [Fre99] Richard B Freeman. The economics of crime. In O. AshenJ lter and D. Card, editors, *Handbook of labor economics*, volume 3, chapter 52, pages 3529–3571. Elsevier, 1999.

- [FS99] Ernst Fehr and Klaus M Schmidt. A theory of fairness, competition, and cooperation. *Quarterly journal of Economics*, pages 817–868, 1999.
- [FS03] E. Fehr and K.M. Schmidt. Theories of fairness and reciprocity: evidence and economic applications. In eds M. Dewatripont et al., editor, *Advances in Economic Theory, Eighth World Congress of the Econometric Society*, volume 1, page 208–5. Cambridge: Cambridge University Press, 2003.
- [FS13] Armin Falk and Nora Szech. Morals and markets. *science*, 340(6133):707–711, 2013.
- [Gar11] R. Sam Garrett. The State of Campaign Finance Policy: Recent Developments and Issues for Congress. *Congressional Research Service, USA*, 2011.
- [GB16] Andrea Geraci and Mark L Bryan. Non-standard work: What’s it worth? comparing alternative measures of workers’ marginal willingness to pay. Technical report, ISER Working Paper Series, 2016.
- [Gho05] Sumantra Ghoshal. Bad management theories are destroying good management practices. *Academy of Management Learning & Education*, 4(1):75–91, 2005.
- [GHP11] Gerd Gigerenzer, Ralph Hertwig, and Thorsten Pachur. *Heuristics: The foundations of adaptive behavior*. Oxford University Press, Inc., 2011.
- [GHT05] Simon Gächter, Benedikt Herrmann, and Christian Thöni. Cross-cultural differences in norm enforcement. *Behavioral and Brain Sciences*, 28(6):822–823, 2005.
- [Gof59] Erving Goffman. *The presentation of self in everyday life (dt.: Wir alle spielen Theater)*. University of Edinburgh Social Sciences Research Centre, 1959.
- [Gos54] Herrmann Heinrich Gossen. *Entwicklung der Gesetze des menschlichen Verkehrs, und der daraus fließenden Regeln für menschliches Handeln*. Friedrich Vieweg & Sohn, Braunschweig, 1854.
- [Hay76] Friedrich A. Hayek. *Law, Legislation and Liberty, Vol. 2, The Mirage of Social Justice*. University of Chicago Press, 1976.
- [HBB<sup>+</sup>05] Joseph Henrich, Robert Boyd, Samuel Bowles, Colin Camerer, Ernst Fehr, Herbert Gintis, Richard McElreath, Michael Alvard, Abigail Barr, Jean Ensminger, Natalie Smith Henrich, Kim Hill, Francisco Gil-White, Michael Gurven, Frank W. Marlowe,

- John Q. Patton, and David Tracer. “Economic man” in cross-cultural perspective: behavioral experiments in 15 small-scale societies. *Behavioral and Brain Sciences*, 28:795–815, 2005.
- [Heb19] Jörg Hebenstreit. *Wahlkampffinanzierung und Demokratie in den USA*. Nomos Verlagsges.mBH & Co, 2019.
- [Hol] Bengt Holmstrom. Pay for performance and beyond, prize lecture, december 8, 2016. <https://www.nobelprize.org/uploads/2018/06/holmstrom-lecture.pdf>.
- [Hol79] Bengt Holmstrom. Moral hazard and observability. *The Bell Journal of Economics*, 10(1):74–91, 1979.
- [Hol91] Gerard J. Holzmann. *Design and validation of computer protocols*. Prentice-Hall, Inc., Upper Saddle River, NJ, USA, 1991.
- [HP85] D. Harel and A. Pnueli. On the development of reactive systems. In Krzysztof R. Apt, editor, *Logics and Models of Concurrent Systems*, pages 477–498. Springer-Verlag, New York, 1985.
- [HP04] Steven Hitlin and Jane Allyn Piliavin. Values: Reviving a dormant concept. *Annu. Rev. Sociol.*, 30:359–393, 2004.
- [HS79] Jaakko Hintikka and Esa Saarinen. *Game-Theoretical Semantics*. Springer, 1979.
- [HTG08] Benedikt Herrmann, Christian Thöni, and Simon Gächter. Anti-social punishment across societies. *Science*, 319(5868):1362–1367, 2008.
- [IECff] IEC. IEC 60050 International Electrotechnical Vocabulary, 2001ff.
- [ILO17] Walk Free Foundation International Labour Organization. Global estimates of modern slavery: Forced labour and forced marriage, 2017.
- [ISO11] ISO/IEC 25010:2011 Systems and software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – System and software quality models, 2011.
- [JANdCC85] Marquis de Jean-Antoine-Nicolas de Caritat Condorcet. *Essai sur l’application de l’analyse à la probabilité des décisions rendues à la pluralité des voix*. Imprimerie Royale, Paris, 1785.
- [Jev71] William Stanley Jevons. *The Theory of Political Economy*. Macmillan & Co, 1871.
- [Jev75] William Stanley Jevons. *Money and the Mechanism of Exchange*. Appleton and Co., New York, 1875.

- [JM76] Michael C. Jensen and William H. Meckling. Theory of the firm: Managerial behaviour, agency costs and ownership structure. *Journal of Financial Economics*, 3:305–360, 1976.
- [JM90] Michael C Jensen and Kevin J Murphy. Performance pay and top-management incentives. *Journal of Political Economy*, 98(2):225–64, April 1990.
- [JM94] Michael C. Jensen and William H. Meckling. The nature of man. *The Journal of Applied Corporate Finance*, pages 4–19, Sommer 1994.
- [Kah11] Daniel Kahneman. *Thinking, fast and slow*. Allen Lane, London, 2011.
- [Kan88] Immanuel Kant. *Kritik der praktischen Vernunft*. z.B. Suhrkamp, Werkausgabe Band VII, 10 edition, 1988.
- [KB04] Cem Kaner and Walter P Bond. Software engineering metrics: What do they measure and how do we know? In *10th International Software Metrics Symposium, Metrics 2004*, pages 1–12, 2004.
- [Key64] John Maynard Keynes. *The general theory of employment, interest and money*. Harcourt Brace Jovanovich, Publishers, Orlando, Florida, 1953/1964. originally published 1936 by Palgrave Macmillan.
- [KL15] Jonathan Katz and Yehuda Lindell. *Introduction to Modern Cryptography*. Chapman & Hall/CRC, 2 edition, 2015.
- [Kle14] Martin A. Klein. *Historical Dictionary of Slavery and Abolition*. Rowman & Littlefield, 2 edition, 2014.
- [KP78] David M. Kreps and Evan L. Porteus. Temporal resolution of uncertainty and dynamic choice theory. *Econometrica*, 46(1):185–200, 1978.
- [KSJ<sup>+</sup>18] Kristiina Kangaspunta, Fabrizio Sarrica, Raggie Johansen, Jesper Samson, Agata Rybarska, and Kelly Whelan. *Global report on trafficking in persons*. United Nations Office on Drugs and Crime, 2018.
- [KW18] Paul Krugman and Robin Wels. *Economics*. Worth, 4 edition, 2018.
- [Lam02] Leslie Lamport. *Specifying systems*. Addison-Wesley Boston, 2002.
- [Lar99] H. Largo, Remo. *Kinderjahre, Die Individualität des Kindes als erzieherische Herausforderung*. Piper, München, Zürich, 1999.

- [Law05] John Law. *Money and Trade Considered: with a Proposal for Supplying the Nation with Money*. GLASGOW, R. & A. Foulis, 1705.
- [LB14] François Lequiller and Derek Blades. *Understanding National Accounts*. OECD, 2014.
- [Lev17] Steven D. Levitt. The economics of crime. *Journal of Political Economy*, 125(6):1920–1925, 2017.
- [LL78] Kuno Lorenz and Paul Lorenzen. *Dialogische Logik*. Wissenschaftliche Buchgesellschaft, Darmstadt, 1978.
- [LPW02] Karl-Gustaf Löfgren, Torsten Persson, and Jörgen W Weibull. Markets with asymmetric information: the contributions of george akerlof, michael spence and joseph stiglitz. *The Scandinavian Journal of Economics*, 104(2):195–211, 2002.
- [Mar49] Karl Marx. *Lohnarbeit und Kapital*. Marx Engels Werke Band 6, S. 397-423, Dietz Verlag Berlin, 1959, 1849.
- [Mar67] Karl Marx. *Das Kapital, Band I*. Marx Engels Werke Band 23, Dietz Verlag Berlin, 1964, 1867.
- [Mar94] Karl Marx. *Das Kapital, Band III*. Marx Engels Werke Band 25, Dietz Verlag Berlin, 1964, 1894.
- [May54] Kenneth Ownsworth May. Intransitivity, utility, and the aggregation of preference patterns. *Econometrica: Journal of the Econometric Society*, pages 1–13, 1954.
- [MCWG95] Andreu Mas-Colell, Michael D. Whinston, and Jerry R. Green. *Microeconomic Theory*. Oxford University Press, 1995.
- [Men71] Carl Menger. *Grundsätze der Volkswirtschaftslehre*. Wilhelm Braumüller, K. K. Hof- und Universitätsbuchhändler, 1871.
- [Mil36] John Stuart Mill. *On the Definition of Political Economy; and on the Method of Investigation Proper to It*. London and Westminster Review, 1836. Reprint, Mill, Essays on Some Unsettled Questions of Political Economy. 1844. Reprint, Collected Works. Vol. 4. Toronto: University of Toronto Press, 1967, pp. 120–64.
- [Mon73] Kent B Monroe. Buyers' subjective perceptions of price. *Journal of marketing research*, 10(1):70–80, 1973.
- [Mor82] Michio Morishima. *Why Has Japan Succeeded? Western technology and the Japanese ethos*. Cambridge University Press, 1982.

- [MPW92] R. Milner, J. Parrow, and D. Walker. A calculus of mobile processes (parts I and II). *Information and Computation*, 100(1):1–77, 1992.
- [MRW77] J. A. McCall, P.K. Richards, and G.F. Walters. Factors in software quality, vol 1, 2, 3. Technical Report RAD-TR-77-369, General Electric Company, 1977.
- [MS14] Mark J Machina and Marciano Siniscalchi. Ambiguity and ambiguity aversion. In *Handbook of the Economics of Risk and Uncertainty*, volume 1, pages 729–807. Elsevier, 2014.
- [Mye91] Roger B. Myerson. *Game Theory: Analysis of Conflict*. Harvard University Press, Cambridge, Massachusetts, 1991. reprinted 1997 as paperback.
- [Mye09] Roger B Myerson. Learning from schelling’s strategy of conflict. *Journal of Economic Literature*, 47(4):1109–25, 2009.
- [NBF<sup>+</sup>16] Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. *Bitcoin and cryptocurrency technologies: a comprehensive introduction*. Princeton University Press, 2016.
- [Nel70] Phillip Nelson. Information and consumer behavior. *Journal of Political Economy*, 78(2):311–29, 1970.
- [O<sup>+</sup>19] World Health Organization et al. *The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines*. Geneva: World Health Organization, 10 edition, 2019.
- [ODF<sup>+</sup>03] John P. O’Doherty, Peter Dayan, Karl Friston, Hugo Critchley, and Raymond J. Dolan. Temporal difference models and reward-related learning in the human brain. *Neuron*, 28:329–337, 2003.
- [OR20] Martin J. Osborne and Ariel Rubinstein. *Models in Microeconomic Theory*. Open Book Publishers, Cambridge, UK, 2020.
- [otU10] Supreme Court of the USA. Citizen United v. Federal Election Commission, 558 U.S. 310, 2010.
- [Per95] Joseph Persky. The ethology of homo economicus. *Journal of Economic Perspectives*, 9(2):221–231, 1995.
- [Pla67] Plato. *Plato in Twelve Volumes*. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd., 1967. Vol. 3, translated by W.R.M. Lamb.

- [Pol01] Karl Polanyi. *The great transformation: the political and economic origins of our time*. Beacon Press, Boston, 2001. Originally published: New York: Farrar & Rinehart, 1944 and reprinted in 1957 by Beacon in Boston.
- [Pos07] Stefan Poslad. Specifying protocols for multi-agent systems interaction. *ACM Trans. Auton. Adapt. Syst.*, 2(4), November 2007.
- [Pre99] Canice Prendergast. The provision of incentives in firms. *Journal of Economic Literature*, 37:7–63, 1999.
- [PWJ18] Irene Papanicolas, Liana R Woskie, and Ashish K Jha. Health care spending in the united states and other high-income countries. *Jama*, 319(10):1024–1039, 2018.
- [Ree61] Rosser Reeves. *Reality in Advertising*. Knopf, New York, 1961.
- [Rei16] Johannes Reich. Two limitations of our knowledge of quality. *CoRR*, abs/1609.05936, 2016.
- [Rei20a] Johannes Reich. Composition, cooperation, and coordination of computational systems. *preprint arXiv:1602.07065*, 2016/2020.
- [Rei20b] Johannes Reich. A theory of interaction semantics. *preprint arXiv:2007.06258*, 2020.
- [Ric21] David Ricardo. *On the Principles of Political Economy and Taxation*. London: John Murray, 3 edition, 1821.
- [Rob32] Lionell Robbins. *An Essay on the Nature and Significance of Economic Science*. London: Macmillan, 1932.
- [Rob38] Lionel Robbins. Interpersonal comparisons of utility: a comment. *The Economic Journal*, 48(192):635–41, 1938.
- [Rou16] Tim Roughgarden. *Twenty Lectures on Algorithmic Game Theory*. Cambridge University Press, 2016.
- [RS20] Johannes Reich and Tizian Schröder. A simple classification of discrete system interactions and some consequences for the solution of the interoperability puzzle. *ifac 2020*, 2020.
- [Rö18] Dagmar Röhrlich. Neue Medikamente: Hoffnungsträger und Preistreiber. *Deutschlandfunk*, August 2018.
- [Sak09] Jacques Sakarovitch. *Elements of Automata Theory*. Cambridge University Press, 2009.
- [SB87] Shalom H Schwartz and Wolfgang Bilsky. Toward a universal psychological structure of human values. *Journal of personality and social psychology*, 53(3):550, 1987.



- [Sch80] Thomas C Schelling. *The Strategy of Conflict*. Harvard University Press, 1980.
- [Sch11] Wolfram Schultz. Potential vulnerabilities of neuronal reward, risk, and decision mechanisms to addictive drugs. *Neuron*, 69(4):603–617, 2011.
- [Sch15] Wolfram Schultz. Neuronal Reward and Decision Signals: From Theories to Data. *Physiological reviews*, 95(3):853—951, 2015.
- [Sel78] Larry Selden. A new representation of preferences over "certain x uncertain" consumption pairs: The "ordinal certainty equivalent" hypothesis. *Econometrica: Journal of the Econometric Society*, pages 1045–1060, 1978.
- [Sen70] Amartya Sen. *Collective Choice and Social Welfare*. Edinburgh: Oliver and Boyd; San Francisco: Holden-Day Inc., 1970. Reprint as extended version in 2017 by Harvard University Press.
- [Sen99] Amartya Sen. *Development as Freedom*. New York, Alfred A. Knopf, 1999.
- [Sen08] Amartya Sen. The Discipline of Economics. *Economica*, 75:617–628, 2008.
- [sFR21] "Reporters sans Frontier (RSF)". "world press freedom index", 2021. <https://rsf.org/fr/classement>.
- [Sha48] Claude E. Shannon. A Mathematical Theory of Information. *Bell System Technical Journal*, 27:379–423, 623–656, 1948.
- [Sha49] Claude E. Shannon. Communication in the Presence of Noise. *Proceedings of the IRE*, 37(1):10–21, 1949.
- [Sim78] Herbert A Simon. Nobel prize lecture: Rational decision-making in business organizations. *Nobelprize.org*, 1978.
- [SJT98] Cass R Sunstein, Christine Jolls, and Richard H Thaler. A behavioral approach to law and economics. *Stanford Law Review*, 50:1471, 1998.
- [Ski53] Burrhus F. Skinner. *Science and Human Behavior*. New York: The Free Press, 1953. deutsch: Wissenschaft und menschliches Verhalten, Kindler, München 1973.
- [Smi76] Adam Smith. *An inquiry into the nature and causes of the Wealth of Nations*. Methuen & Co, London, also: The Glasgow Edition of the Works and Correspondence of Adam Smith, vol. II, edited by R. H. Campbell and A. S. Skinner. Oxford University Press, 1976, 1776.

- [SSF09] Joseph E. Stiglitz, Amartya Sen, and Jean-Paul Fitoussi. Report by the Commission on the Measurement of Economic Performance and Social Progress, 2009.
- [SSZ14] Klaus M Schmidt, Martin Spann, and Robert Zeithammer. Pay what you want as a marketing strategy in monopolistic and competitive markets. *Management Science*, 61(6):1217–1236, 2014.
- [Tha15] Richard H Thaler. *Misbehaving: The making of behavioral economics*. WW Norton & Company New York, London, 2015.
- [UEO<sup>+</sup>08] UN, EC, OECD, IMF, and WBG. System of national accounts, 2008.
- [Vic61] William Vickrey. Counterspeculation, auctions, and competitive sealed tenders. *The Journal of finance*, 16(1):8–37, 1961.
- [vNM44] Johann von Neumann and Oskar Morgenstern. *Theory of Games and Economic Behavior*. Princeton University Press, 1944.
- [Wal74] Léon Walras. *Éléments d'économie politique pure, ou, Théorie de la richesse sociale*. Corbaz, 1874.
- [WDS01] Pascale Waelti, Anthony Dickinson, and Wolfram Schultz. Dopamine responses comply with basic assumptions of formal learning theory. *Nature*, 412(5):43–48, 2001.
- [Web45] Max Weber. Die protestantische Ethik und der Geist des Kapitalismus. *Archiv für Sozialwissenschaft und Sozialpolitik*, pages (20) 1–54, (21)1–110, 1904,5. Also published and introduced by Dirk Kaesler, 3.ed. Beck, München 2010.
- [Wei90] Philippe Weil. Nonexpected utility in macroeconomics. *The Quarterly Journal of Economics*, 105(1):29–42, 1990.
- [Wit21] Ludwig Wittgenstein. *Logisch-philosophische Abhandlung, Tractatus logico-philosophicus*. Oswalds Annalen der Naturphilosophie, 1921. Erschienen z.B. bei Suhrkamp, Frankfurt am Main, 1998.
- [Wit53] Ludwig Wittgenstein. *Philosophical Investigations*. Oxford: Basil Blackwell, 1953. Transl. by G. E. M. Anscombe.
- [Woe16] Ludger Woessmann. The economic case for education. *Education Economics*, 24(1):3–32, 2016. Also published as EENEE Analytical Report No. 20, Prepared for the European Commission, 2014.