

Presumptions and Burdens of Proof

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Abstract. This paper studies the logical modelling of presumptions and their effects on the burden of proof. Presumptions are modelled as default rules and their effect on the burden of proof is defined in terms of a distinction between the burden of production, the burden of persuasion and the tactical burden of proof. These notions are logically characterised in such a way that presumptions enable a party to fulfil a burden of production or persuasion while shifting a tactical burden to the other party. Finally, it is shown how debates about what can be presumed can be modelled as debates about the backings of default rules.

Keywords. Evidence, burden of proof, presumptions, argumentation.

1. Introduction

This paper studies the logical modelling of presumptions and their effect on the burden of proof. The law uses various techniques that affect the burden of proof, including the separation of general rules and their exceptions and the use of explicit presumptions. As is well known, both these legislative techniques have their logical counterpart in non-monotonic logics. Accordingly, it has been argued that reasoning with burden of proof can be formalised simply by using one of these logics. Specifically for presumptions it has been argued that they are default statements and can be formalised as such [6]: applying a logical machinery for handling defaults then automatically induces an allocation of the burden of proof. Thus presumptions are treated as a logical phenomenon.

However, recently proposals have been made that deviate from this view. In [3] and [4] the burden of proof is allocated at the dialogical level by special speech acts, while in [7], also at the dialogical level, an explicit speech act for expressing presumptions is introduced. (In [1] the term ‘presumption’ is also used but in a technical sense, which is not meant to reflect its meaning in legal discourse.)

The purpose of this paper is to clarify matters and to see how all these proposals relate. In particular, we want to answer the following questions:

1. What is a presumption and how can it be logically characterised?
2. How do presumptions affect the burden of proof?
3. How can debates about what can be presumed be modelled?

Our answer to question (1) will, following [6], be that presumptions are default rules and can be represented as such in any suitable nonmonotonic logic. In answering question

(2) we shall see that three notions of burden of proof must be distinguished, namely, the burden of *production*, the burden of *persuasion* and the *tactical* burden of proof. Finally, debates about presumptions will be modelled as debates about the backing of default rules. A by-product of the latter will be a classification of types of legal presumptions. Our analysis will use the formal argumentation system of [5], though other systems could be used as well, such as the recent [1].

2. Logical preliminaries

We first briefly summarise the logic of [5] (let us call it IS, for Inference System). IS is a logic for defeasible argumentation that is expressive enough to deal with contradictory rules, rules with assumptions, inapplicability statements and priority rules. Information is expressed as a set of rules in the language of extended logic programming, which has both negation as failure (\sim) and classical, or strong negation (\neg). In addition, each rule is preceded by a term, its name. Rules are *strict*, represented with \rightarrow , or else *defeasible*, represented with \Rightarrow . Facts are represented as strict rules with empty antecedents. The input information of the system is a set of strict and defeasible rules, which is called an *ordered theory* ('ordered' since a partial preorder on the defeasible rules is assumed).

Arguments can be formed by chaining rules, ignoring weakly negated antecedents. Conflicts between arguments are decided according to a binary relation of *defeat* among arguments, which is partly induced by rule priorities. The information about these priorities is itself presented as premises in the logical language, so that priorities may be reasoned about as any other legal issue.

There are three ways in which an argument Arg_2 can defeat an argument Arg_1 . The first is *assumption* defeat (in [5] called "undercutting" defeat), which occurs if a rule in Arg_1 contains $\sim L$ in its body, while Arg_2 has a conclusion L (note that $\sim L$ reads as ' L cannot be derived'). The other two forms of defeat are only possible if Arg_1 does not assumption-defeat Arg_2 . One way is by *excluding* an argument, which happens when Arg_2 concludes for some rule r in Arg_1 that r is not applicable (formalised as $\neg\text{appl}(r)$). The other is by *rebutting* an argument, which happens when Arg_1 and Arg_2 contain rules that are in a head-to-head conflict and Arg_2 's rule is not worse than the conflicting rule in Arg_1 . Note that all these attacks can be targeted at the final rule or conclusion of an argument but also at each intermediate rule or conclusion.

Arguments are assigned a dialectical status in terms of three classes: the 'winning' or *justified* arguments, the 'losing' or *overruled* arguments, and the 'ties', i.e., the *defensible* arguments. The same statuses can also be defined for propositions: a proposition is *justified* if there exists a justified argument for it, and it is *defensible* if it is not justified but there exists a defensible argument for it.

Whether an argument is justified can be tested in a so-called argument game between a proponent and an opponent for the argument. Proponent starts with an argument that he wants to prove justified and then each player must either defeat the other player's previous argument or move a priority argument that stops the previous argument from defeating its target. Moreover, proponent's defeating arguments must be such that they *strictly* defeat opponent's arguments, i.e., they may not in turn be defeated by their targets. A player wins if the other player has run out of moves. The initial argument is *justified* if the proponent has a winning strategy in this game. Non-justified arguments are *overruled*

if they are defeated by a justified argument, otherwise they are *defensible*. This argument game is sound and complete with respect to grounded semantics.

In this paper we assume that the exchange of arguments in a dispute is regulated by some legal procedure. However, we abstract from its details and simply assume that a dispute consists of a sequence of stages which are characterised by different ordered theories and where the parties can move from one stage to another by adding arguments. A stage then consists of the premises of all arguments stated at that point. The outcome of a dispute is determined by applying the argument game of IS to the final stage. We also apply the argument game to intermediate stages, to verify what would be the outcome of the dispute if an intermediate stage were the final stage. Note that the final stage may also contain evaluative arguments stated by the adjudicator. For instance, he could decide evidential arguments to be *internally invalid* by moving an inapplicability argument, thus expressing that the evidence is in itself too weak to support its conclusion. Or he could decide on the *dialectical validity* of an evidential by moving priority arguments, thus deciding whether the evidence outweighs its counterevidence according to the applicable standard of proof.

3. Legal-theoretical analysis

In this section we analyse some examples involving burden of proof and discuss how they can be characterised in terms of IS. This will give rise to a distinction between three types of burden of proof, namely the burden of persuasion, the burden of production and the tactical burden. We then discuss the logical form of presumptions and study their relation to the three notions of burden of proof. These notions are (sometimes with other terms) explicitly distinguished in common law jurisdictions (see e.g. [8], whose analysis we essentially adopt). However, our purpose is to give a rational analysis that should be relevant for any legal system and therefore we will abstract from procedural aspects of specific legal systems.

3.1. Three types of burden of proof

The main principle governing burden of proof is that the party who makes a legal claim must prove the operative legal facts for that claim, i.e., the facts that according to the law are ordinarily sufficient reasons for the claim. One way in which the law designates the operative facts for a claim is to separate general rules from exceptions. For instance, in Dutch law a general rule says that killing with intent is punishable as being manslaughter, but a separate rule expresses an exception in case of self-defence. Thus the law expresses that the operative facts for ‘manslaughter’, to be proven by the prosecution, are ‘killing’ and ‘with intent’. This can be expressed in IS as follows.

$$\begin{aligned} r_1: & \text{ killing} \wedge \text{ intent} \Rightarrow \text{manslaughter} \\ r_2: & \text{ selfdefence} \Rightarrow \neg \text{appl}(r_1) \end{aligned}$$

‘Proven’ here means that the proposition is supported by grounds that are sufficient for endorsing it at the end of the proceedings. Different legal system specify the standards for sufficiency of grounds in different ways. For instance, American law says that the grounds must exclude any reasonable doubt (in criminal law) or should provide preponderant evidence (in civil law), while Dutch law says that they should determine the in-

ner conviction of the judge. We will use the term *burden of persuasion* for the task to prove a proposition in this sense according to some standard of proof. In IS it can be characterised as the requirement that in the final stage of the dispute the proposition must be justified. Proof standards can be incorporated in the definition of the rebuttal relation between arguments, by making sure that a stronger argument strictly defeats a weaker argument by rebutting it only if the degree to which it is stronger satisfies the applicable proof standard; otherwise both arguments rebut each other.

Consider now a case of alleged manslaughter. Assuming that the prosecution can satisfy his burden of persuasion with respect to `kill` and `intent`, the accused can only escape conviction by providing evidence of an exception to r_1 , such as that the killing was done in self-defence. For instance, the defence could provide a witness who says that the victim threatened the accused with a knife. (Below we will only list rules and regard it as obvious how they can be used to build the relevant arguments.)

```
f1: witness W1 says "knife"
r3: witness W1 says "knife" ⇒ knife
r4: knife ⇒ threat to life
r5: killing ∧ threat to life ⇒ selfdefence
```

However, in most legal systems the defence does not have the burden of persuasion with respect to `selfdefence`; all the defence must do is produce enough evidence so that the issue of self-defence is raised and must be addressed by the fact finder. If no evidence supporting `selfdefence` is produced, the judge is bound to apply r_1 . Accordingly, this type of burden is often called the *burden of production*. In IS it is captured by the fact that if no such evidence is adduced then no counterargument to the application of rule r_1 can be constructed. This is the negative side of the burden of production but it also has a positive side since not just any evidence counts as fulfilment: it must introduce sufficient doubt on whether the fact finder should rule that there is no self-defence. In terms of IS it means that if an evidential argument for `selfdefence` is constructed, then ‘reasonable minds’ can disagree about whether the fact finder has to rule this argument internally invalid. (Recall that this can be done by moving an argument for $\neg\text{appl}(r_3)$ or $\neg\text{appl}(r_4)$.) In Anglo-American civil law the question whether the burden of production has been fulfilled is relevant, for instance, for deciding whether an issue must be brought before a jury; however, as said above, we will abstract from such system-specific aspects.

Suppose the defence moves an argument that fulfils the burden of production. Then if the current stage were the final stage, there is a reasonable chance the defence would win. To prevent the risk of losing, the prosecution should therefore provide additional evidence to take away the reasons for doubt raised by the defence. In other words, the prosecution now also has the burden of persuasion for $\neg\text{selfdefence}$. Let us assume that the prosecution attempts to fulfil it with a witness who declares that the accused had enough time to run away.

```
f2: witness W2 says "time to run away"
r6: witness W2 says "time to run away" ⇒ time to run away
r7: knife ∧ time to run away ⇒ ¬threat to life
```

Let us also assume that the evidence is of the kind that is usually sufficient to persuade the trier of fact, i.e., it is likely that the trier of fact will move a priority argument with conclusion $r_7 > r_4$, thus making the proposition `manslaughter` justified again. This creates another burden for the defence, viz. to provide counterevidence that reinstates the

reasonable doubt on self-defence. For example, the defence could provide evidence that the witness is a friend of the victim, which makes her unreliable.

f_3 : witness W2 is friend of victim
 r_8 : witness W2 is friend of victim $\Rightarrow \neg\text{appl}(r_6)$

We will call this burden the *tactical burden of proof*. In the words of [8] it is a matter of tactical evaluation in that a party must assess the risk of losing on an issue if no further evidence concerning that issue is produced. Note that both a burden of persuasion and a burden of production imply a tactical burden but not vice versa and that the burdens of persuasion and production do not imply each other.

In IS a tactical burden is captured by the situation that at a certain stage of the dispute, the proposition $\neg\text{selfdefence}$ is justified so that the defence, to avoid that the case is decided on this basis, should try to introduce new evidence that turns the status of this proposition into ‘defensible’ or ‘overruled’. More generally, at a given stage a party has a tactical burden of proof with regard to an issue if the evidence and the arguments thus far provided lead to assessing that issue in a way that goes against that party (and so would likely be concluded by the triers of fact if no new elements were provided to them before the end of the proceedings).

Let us examine how the three kinds of burden rest on the parties during a dispute. The burdens of production and persuasion are fixed: they cannot shift from one party to the other. The burden of production on an issue is fulfilled as soon as the burdened party provides the required evidence on that issue and after that is no longer relevant. The burden of persuasion, once created, remains on a party until the end of the discussion of the case, namely, until the point when a party is precluded from giving any further input to the fact-finders. By contrast, the tactical burden on an issue is not fixed; it can shift between the parties any number of times during the discussion of the case, depending on who would likely win on that issue if no more evidence were provided.

3.2. The logical form and function of presumptions

We now investigate the relation between presumptions and the three types of burden of proof. We first argue that the logical form of presumptions is that of a conditional default rule. Our argument consists of the observation that the things that are called presumptions in law usually have this form. Examples of unconditional presumptions, such as the well-known ones of innocence and good faith, will be treated as boundary cases with tautological antecedent. Space limitations force us to leave an extensive survey of examples for a future occasion and to confine ourselves to just a few examples.

Our first example is from the Dutch Civil Code, which contains a rule that possession of a movable good creates a presumption of ownership. This presumption can be used in applying any rule of the Civil Code that has ownership as a condition. Clearly, this presumption has a conditional form, captured by r_2 below:

r_1 : owner \wedge damaged \Rightarrow compensation
 r_2 : possession \Rightarrow owner

Note that, by contrast, our above manslaughter example is not a case of presumptions since it does not involve an explicit rule *killing is usually not done in self-defence*. Instead it is an example of an implicit exception.

Our second example concerns a rule from Italian tort law according to which a surgeon who causes injury to a patient by being negligent is liable for compensation. Once the patient has proven that an injury was caused and that the operation was normal, negligence is presumed so that the surgeon has the burden of proving that he was not negligent. Rule r_4 below shows that this presumption also has the form of a conditional default rule:

r_3 : `injured in operation \wedge negligence \Rightarrow compensation`
 r_4 : `injured in operation \wedge normal operation \Rightarrow negligence`

Finally, the following definition of a presumption in legislation of the US state of Wisconsin clearly expresses the conditional nature of presumptions:

Except as provided by statute, a presumption recognized at common law or created by statute, including statutory provisions that certain basic facts are prima facie evidence of other facts, imposes on the party relying on the presumption the burden of proving the basic facts, but once the basic facts are found to exist the presumption imposes on the party against whom it is directed the burden of proving that the nonexistence of the presumed fact is more probable than its existence. (*Updated 03-04 Wis. Stats. Database, Sect. 903.01.*)

This says that when the antecedent of a presumption has been proven, its consequent can be presumed.

Let us now see how the use of presumptions affects the three types of burden of proof. The ownerships presumption can be analysed in the same way as the manslaughter example. Suppose plaintiff demands compensation on the ground that defendant damaged his bicycle. Then plaintiff has the burdens of production and persuasion that the bicycle was damaged and that he owned the bicycle. One way to prove the latter is by proving that he possessed the bicycle, after which ownership can be presumed.

f_1 : `possession`

Thus the presumption is invoked to fulfil a burden of persuasion. Defendant then has the tactical burden of producing counterevidence that introduces reasonable doubt on whether plaintiff really owned the bicycle, for instance, by providing evidence that suggests plaintiff had stolen it. Note that this is not a burden of production since evidence on the issue of ownership has already been provided, namely `possession`.

f_2 : `witness W1 says "stolen"`
 r_5 : `witness W1 says "stolen" \Rightarrow stolen`
 r_6 : `stolen \Rightarrow \neg owner`

Plaintiff's burden of persuasion for ownership now induces a tactical burden for plaintiff to convince the judge that he has not stolen the bicycle. In terms of IS, plaintiff must make sure that in the final stage of the dispute defendant's argument for `stolen` is overruled.

At first sight, it would seem that it is always the prosecution (in criminal cases) and the plaintiff (in civil cases) who has the burden of persuasion. For criminal law this seems indeed the case but for civil law things are more complicated, as illustrated by our second example of an explicit presumption. Suppose plaintiff can fulfil his burden of persuasion that injury was caused during an operation which was normal. Then if defendant remains silent, the presumption r_4 makes that plaintiff should be awarded compensation, so defendant has a tactical burden with respect to \neg negligence. For instance, the doctor could argue that he has a good track record for such operations.

$r_7: \neg \text{past mistakes} \Rightarrow \neg \text{negligence}$

However, is it sufficient for defendant to cast doubt in this issue, or must defendant convince the judge that there was no negligence? In Italian law the latter holds so the defendant also has the burden of persuasion with respect to the exception. In terms of IS, defendant must persuade the judge to move a priority argument for $r_7 > r_4$.

In [2] it was argued that the same problem can arise with implicit exceptions. Moreover, it was shown that such cases pose a problem for our logic IS and indeed for any current nonmonotonic logic. Briefly, in IS the problem is that the two players (proponent and opponent) are governed by different but fixed rules of the game: throughout an argument game, proponent's counterarguments must be strictly defeating (i.e., doubt-removing) while opponent's counterarguments can be weakly defeating (i.e., doubt-raising). So counterarguments by opponent always succeed if they cast doubt. However, our example shows that doubt-raising arguments are insufficient if the opponent has the burden of persuasion: in that case doubt-removing arguments are needed.

To meet this demand, in [2] the argument game of [5] was modified to allow that the two players in a dialogue (plaintiff and defendant) can have different dialectical roles (proponent or opponent) for different propositions. (Let us call the resulting system LIS, for Litigation Inference System). So, for instance, plaintiff in the medical case could be proponent of `injury during operation` while he could be opponent of `\neg negligence`. Accordingly, LIS assumes as input not just an ordered set of rules but also an allocation of proof burdens for literals to plaintiff and defendant, expressing who has the burden of persuasion for each proposition.

Summarising the effects of presumptions on the three types of burden of proof, presumptions are a way to fulfil a burden of production and persuasion and, once invoked, they shift the tactical burden to the other party. It may be that they also create a burden of persuasion on the other party, but that is a separate issue, which is not a matter of logic but of law (see e.g. the above fragment from Wisconsin State Law).

4. Formalising debates about what can be presumed

We now turn to the question how debates on what can be presumed can be modelled. Note that this question is not the same as the questions how debates on the burdens of persuasion and production can be modelled. We leave these questions for future research. Since we have argued that presumptions can be characterised as default rules, disputes about what can be presumed should concern whether such a default rule holds. Let us, adopting familiar terminology, call this the issue whether a rule is *backed*.

Usually in legal knowledge-based systems the backing of a rule is not represented at all: instead it is simply assumed that the elicited knowledge is legally correct. However, when the aim of a system is to model debates about whether a rule is legally correct, its backing must somehow be represented. Then the question arises whether it should be represented such that the backing of a rule can be presumed in the absence of reasons to the contrary. The answer to this question will depend on the nature of the application. If the answer is negative, then each rule r must in IS be given an additional condition `backed(r)` and to apply the rule an argument must be provided that this condition holds. If instead the backing can be presumed, then in IS basically two methods are available. One of them is to define a fourth way to attack arguments, viz. *backing attack*, consisting

of an argument for $\neg\text{backed}(r)$ for some rule r used in the attacked argument. Another method is to give each defeasible rule r a condition $\sim \neg\text{backed}(r)$. Note that in both methods a rule is backed if there are no reasons to the contrary. Note also that in all three methods any argument for $\neg\text{backed}(r)$ defeats any argument that uses r : in the first method by rebutting a subargument of the argument applying r , in the second method by a special backing attack, and in the third method by assumption attack. Naturally, in all three methods such an argument for $\neg\text{backed}(r)$ can itself be attacked in any way allowed by the logic. Because of these similarities we will in the remainder of this paper not distinguish between the three representation methods and instead concentrate on representing rules about whether some other rule is backed.

Let us now illustrate this analysis with some examples. The main point of these examples is to argue that our method allows for a straightforward representation of a natural legal typology of presumptions.

Some presumptions are backed as being defined in statutes (*source-based presumptions*). This holds, for instance, for the ownerships presumption in Dutch civil law.

$$b_1: \text{ in statute}(r, s) \Rightarrow \text{backed}(r)$$

(here s is an identifier for the statute section containing r). Other presumptions are declared as such in precedents. This holds, for instance, for the negligence presumption in the Italian medical example:

$$b_2: \text{ decided in precedent}(r, p) \Rightarrow \text{backed}(r)$$

(where p denotes the precedent declaring r as a presumption).

When sources for presumptions are unavailable (as in precedent p before its final decision), presumptions must be backed on substantial grounds. A common substantial backing is that the presumption is empirically probable (*probabilistic presumptions*). For instance, in precedent p it could have been argued that when injury is caused during a normal operation, this is, as a matter of empirical regularity, usually due to negligence.

$$b_3: \text{ P}(\text{negligence} \mid \text{normal operation} \ \& \ \text{injury}) \text{ is high} \Rightarrow \text{backed}(r_2)$$

(where $\text{P}(q \mid p)$ denotes the conditional probability of p given q). Alternatively, the presumption could have been backed on policy grounds (*policy presumptions*). For instance, it could have been argued that adopting rule r_2 induces responsible behaviour of surgeons during operations. Against this, it could have been argued that r_2 would instead make that surgeons will avoid risky operations.

$$b_3: \text{ makes surgeons behave responsibly}(r_2) \Rightarrow \text{backed}(r_2)$$

$$b_4: \text{ makes surgeons avoid risky operations}(r_2) \Rightarrow \neg\text{backed}(r_2)$$

Sometimes a presumption is backed by the fact that proving a certain proposition p is much more difficult than proving the opposite (*epistemic presumptions*). Schematically (where $r = q \Rightarrow p$):

$$b_5: \text{ proving } p \text{ in case of } q \text{ is easier than proving } \neg p \Rightarrow \text{backed}(r)$$

One type of case in which the condition of b_5 holds is when one side in a dispute has the better access to the relevant information. Schematically:

$$b_6: \begin{array}{l} \text{ in case of } q \text{ claimant of } p \text{ has better info wrt } p \Rightarrow \\ \text{ proving } p \text{ in case of } q \text{ is easier than proving } \neg p \end{array}$$

Presumptions can also be defended on grounds of fairness (*fairness presumptions*). Dutch labour law allows immediate dismissal if there is a pressing ground for the dismissal and it qualifies refusal of an order for no good reason as one such pressing ground.

r_1 : pressing ground \Rightarrow dismissal allowed
 r_2 : refusal $\wedge \neg$ good reason \Rightarrow pressing ground

In one case (discussed in [4]) some employees dismissed after refusing an order argued that the employer had the burden of proving they had no good reason for their refusal on the grounds that he had refused to listen to their reasons for refusal. The employer argued instead that the employees had to prove that they had a good reason. Arguably this debate was about which of the following presumptions was backed:

r_{3a} : refusal $\Rightarrow \neg$ good reason
 r_{3b} : refusal $\wedge \neg$ heard \Rightarrow good reason

The court decided that the employer had the burden of proof since he had refused to listen to the employees' reasons for refusing his order.

b_7 : refused to listen \Rightarrow backed(r_{3b})

This completes our typology of legal presumptions and their logical representation.

5. Conclusion

In this paper we have investigated the logical modelling of presumptions and their effects on the burden of proof. We have argued that presumptions are default rules and can be represented as such in a suitable nonmonotonic logic. For determining their effect on the burden of proof we had to distinguish between the burden of *production*, the burden of *persuasion* and the *tactical* burden of proof. To summarise, the burden of persuasion is the burden to have a justified argument at the final stage, the tactical burden is the burden during dialogue to introduce new information that would make the decision maker decide in the parties' interest if the new stage were the final stage, and the burden of production is the burden at a given stage in the dialogue to produce an argument that will not be ruled internally invalid by the decision maker regardless of counterevidence. To our knowledge, we are the first to have made a precise logical characterisation of these three types of burden of proof. We have also argued, following [8], that invoking a presumption fulfills a burden of production and/or persuasion while it shifts the tactical burden to the other party. Finally, we have argued that debates about what can be presumed can be modelled in an argumentation logic, as debates about the backings of default rules, and that this representation allows a straightforward representation of a natural legal typology of presumptions.

Our analysis arguably sheds some new light on related research. Firstly, it turns out that [6]'s proposal to model burden of proof in a standard nonmonotonic logic applies to burden of production and the tactical burden but not to burden of persuasion. Furthermore, [7]'s idea to declare presumptions with a special speech act in our opinion ignores that the logical form of presumptions is that of a conditional default rule. In [3] and [4] allocations of the burden of proof are treated at the dialogical level (though no distinction is made between types of burden of proof). Allocations are expressed with a special

speech act, which can be moved in reply to a challenge of a claim. Allocations can also be challenged, which gives rise to metadialogues about who has the burden of proof. This dialogical approach was chosen to reflect that actual disputes about the burden of proof rarely refer to presumptions or the logical form of conditionals. However, in [4] it was suggested that such disputes implicitly are about the backing of a default rule. In [4] this integration of a dialogical and logical treatment of burden of proof was not made formally precise. Here we have brought it within reach by investigating to what extent presumptions can be treated as a logical phenomenon.

Integrating these logical and dialogical accounts of burden of proof is one issue for future research. Other research issues are extending the LIS logic to model debates about the burden of persuasion, and investigating whether our typology of three types of burden of proof is rich enough to account for all phenomena or should be extended.

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