# The desperation threshold: a model to explain decisions in poverty

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# 5 Explaining the paradoxical effects of poverty on decision making: The Desperation Threshold Model

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## 5.1 Abstract

The impacts of poverty and material scarcity on human decision making appear paradoxical. One set of findings associates poverty with risk aversion, whilst another set associates it with risk taking. We present an idealized general model, the 'desperation threshold model' (DTM), that explains how both these accounts can be correct. The DTM posits utility functions with a threshold or 'cliff', a point where utility declines steeply with a small loss of resources because basic needs cannot be met; and a 'rock bottom', a point where utility is not made any worse by further loss of resources, because basic needs are not being met anyway. Above the threshold, people's main concern is not falling below, and they are predicted to avoid risk. Below the threshold, they have little left to lose, their most important concern is jumping above, and they are predicted to take risks that would otherwise be avoided. Versions of this model have been proposed under various names across biology, anthropology, economics and psychology. We review a broad range of relevant empirical evidence from a variety of societal contexts. Though the model primarily concerns individual decision making, it connects to a range of population-scale and societal issues such as: the consequences of economic inequality; the deterrence of crime; and the behavioural consequences and optimal design of the welfare state. We discuss a number of interpretative issues and offer an agenda for future DTM research that bridges disciplines.

## 5.2 Poverty and risk taking: A paradoxical relationship

In a sample of 17,000 Swedes, those with fewer financial resources are less likely to invest in risky assets like stocks and shares. The relationship holds even after controlling for how much money they invest in total. It's not just that poorer individuals save less (which is unsurprisingly the case), it's that they are less likely to choose risky assets for what they do save. Since risky assets generally have higher long-run financial returns, poorer individuals, by avoiding risk, may be missing out on long-term gains. Taking less risk when having fewer resources seems perfectly intuitive: one has less of a buffer in the event of a bad outcome; one's first priority should be to avoid the financial situation getting any worse.

Yet consider U.S. state lotteries. These are highly risky: for every dollar handed over, the average return is only 70c; but that 70c on average is distributed as a large chance of getting nothing and a small chance of getting a big payout. Income is a strong predictor of buying lottery tickets: the lower people's incomes, the more they buy. In the 1% poorest zip codes in states with lotteries, the average adult spends $600 a year on lottery tickets, compared to $150 a year in the richest 1%; four times as much in absolute terms, and thirty times as much as a share of income (Economist, 2024). This seems intuitive too: when people have so little that they can't make ends meet, they will grasp at any chance of getting a lump more resources, even a highly risky one.

These two examples illustrate two plausible accounts of what poverty does to decision making: the first, that people in poverty cannot afford to take risk; the second, that they are especially prone to do so. Both accounts have been discussed and supported in the literature over decades (Kish-Gephart, 2017). As a consequence, the literature is confusing, containing "at least two distinct and, prima facie, inconsistent views" (A. Banerjee, 2004, p. 60): that people in poverty have too much to lose, and hence have a safety-first attitude (Donkers et al., 2001; Guiso & Paiella, 2008; Haushofer & Fehr, 2014; M. Lipton, 1968); and that they have little left to lose, and hence throw prudence out the window (A. V. Banerjee & Newman, 1994; Haisley et al., 2008; Hsieh & Pugh, 1993; Patterson, 1991; Pratt & Cullen, 2005).

This paper presents and discusses an idealised model of decision making, the desperation threshold model (DTM). The DTM does not just accommodate, but actually predicts, that poverty would sometimes increase and sometimes decrease risk taking. The DTM assumes that the relationship between material resources and utility, rather than being a wholly concave function, contains a cliff edge and a 'rock bottom'. This is because people have some bundle of basic needs that they seek to satisfy as a first and most important priority. If they feel they are just succeeding in doing so, they are on top of the cliff. Once they fail to do so, or seem likely to fail, they fall to rock bottom. The implication of poverty for decision making thus depends on whether poverty puts a person just below or just above the cliff edge. Just below, it matters little whether one has missed by a little or a lot: one is in dire straits and has 'little more to lose'. Just above, though, one has a great deal to lose: usually more, in fact, than to gain by taking risks for further acquisition.

The basic idea of the DTM has been proposed or implied in several disciplines at several times. It has generated multiple research programs, which often make little reference to one another. In this paper, we aim to: bring together the diverse versions of the DTM under one name; clarify assumptions, implications and conceptual issues; and review the relevant empirical evidence. The DTM also provides a bridge between individual-level (micro) and population-level (macro) processes. As such, it can be a parsimonious lens for understanding population-scale phenomena, such as the effects of inequality and different kinds of institutions on behaviour. We will review some of these societal applications, discuss interpretative issues, and make some suggestions for how DTM research could be extended and refined later. First, though, we present the DTM itself.

## 5.3 The desperation threshold model

### 5.3.1 The core of the model

To introduce the DTM, we employ the language of rational choice theory and utility functions. This should not be seen as a commitment to the idea that humans are always rational and deliberate, or maximise a single currency. Rather, it is a useful though simplified idealisation to make explicit the pattern of valuation that we propose.

The DTM posits that the mapping between material resources and utility is non-linear with a particular shape. Namely, as one moves in the direction from more to less resources, there must be a point where utility declines with increasing steepness, like dropping off a cliff. At a lower resource point still, this steep decline must level out at rock bottom. Two examples of such mappings are shown in figure 5.1A. The dotted line shows the 'starvation threshold' of Stephens (1981) version, whilst the dashed line is a sigmoid curve, another utility function often discussed in instantiations of the DTM (e.g. Kuznar, 2001). We consider these both instances of DTMs.

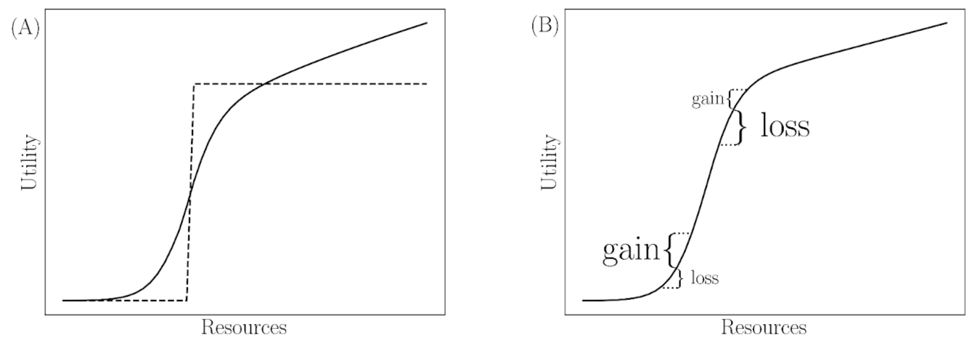


Figure 5.1: (A) Utility functions that count as instances of the DTM. The dotted line represents Stephens' (1981) classic biological model, where the step is starvation. The dashed line represents a sigmoid function, a more general formulation that also qualifies as a DTM. (B) Graphical illustration of why the curvature of the utility function determines optimal risk taking. In the convex segment, a resource gain brings more utility than an equal loss takes away. In the concave segment, the reverse is true.

The central insight found in all versions of the DTM concerns risky decisions, where risk is defined as variance in outcomes. For example, a lottery that might result in a £10 win, or might result in the loss of the £2 stake, is risky. Accepting £1 for sure is not. The utility impact of a risky decision depends on where on the resource curve one currently stands (figure 5.1B). If one's current resources put one at the top of the steep section, then a loss would be much worse than a gain would be good. Even a small loss of resources would make one markedly worse off in utility. This makes the (smaller) potential upside gain much less interesting than avoiding the possible loss. If one is currently at the bottom of the cliff, things can barely be any worse, so the downside risk of a risky decision is not so consequential. By contrast, a small gain in resources could mean a huge utility gain. Thus, an agent should be averse to risk when resources are above the threshold level, and choose risk when resources are below. The principle surfaces in many contexts. In the last minutes of a knockout game of football (soccer), the leading team typically plays safe and tries to use up time, avoiding risk. The trailing team, on the contrary, takes desperate actions, such as the goalkeeper leaving their net empty to try to score a goal. What is usually a terrible idea becomes reasonable due to a threshold: losing 1-0 is not much worse than losing 2-0; but drawing 1-1 is dramatically better.

### 5.3.2 Grounding the basic assumptions

The DTM is constituted by the twin elements of: a cliff in the utility function, and a rock bottom. Why might this be a reasonable pattern to assume?

We begin by the cliff, i.e. a steep, or vertical, section around the basic needs level. This assumption is not radically new. Economists routinely assume 'diminishing marginal utility': as consumption increases, the extra pleasure derived from every dollar spent decreases. This assumption is reasonable. People will use their first available resources to satisfy the desires that boost utility the most, and then turn to progressively less impactful ones. To put this the other way around, the poorer one gets, the more painful it is to lose any further money, as this requires cuts to increasingly impactful or 'basic' goods. The assumption of diminishing marginal returns is also validated empirically. When we replace the theoretical notion of utility with measured life satisfaction, the overall relationship we observe with income is one whose gradient flattens out as resources increase (see e.g. Nettle & Dickins, 2022).

For some fundamental goods, one cannot get any of the benefit for any less than all of the expenditure. For example, a person can be evicted for paying 90% of their rent; only if they pay 100% do they get the right to a home. This produces a near-verticality in the utility function around the point where the home is secured. Utility functions can thus have extremely steep or even vertical regions, where resources are making the difference between securing or losing goods that satisfy basic needs.

We see basic needs as encompassing material safety and bodily integrity (food, shelter, warmth), but also what has been termed 'the social basis of respect' (Rawls, 1971). This is whatever one needs to have in order to be considered a recognised and adequate member of society; to be, as Sen (1983) puts it: 'free from public shame from failure to satisfy convention' (p. 167). Smith (1776) similarly stated that 'by necessities, I understand not only the commodities which are indispensably necessary for the support of life, but whatever the customs of the country renders it indecent for creditable people...to be without. [...] a creditable day labourer would be ashamed to appear in public without a linen shirt.' (p. 869-870). The British sociologist Townsend argued that the poverty line was a point where, descending the income scale, a large number of families dropped out or were excluded from their community's style of living (Townsend, 1979). These various formulations all capture the idea that there are levels of income below which not just somatic but also basic social integrity is endangered.

As well as a cliff, the DTM assumes a rock bottom. There are several ways to justify this assumption. The first is a reductio ad absurdum: what would it mean for utility to go down endlessly? There must be a level of resources x so inadequate that the individual cannot satisfy any needs at all. Having 90% of x or 50% of x is not actually any worse than having x: the number of needs that can be satisfied is the same. Resources and needs satisfaction must then become decoupled at some point. Note that this decoupling, as well as occurring at the point where no needs can be met, also occurs if there is a 'safety net' and the individual has reached it. By a safety net we mean any mechanism that guarantees minimal well being, such as social assistance or the welfare state, or 'outside options' like fleeing or defaulting (Kohler & West, 1996). Once one has reached the safety net level, a further loss of personal financial resources does not necessarily entail a further loss of utility.

A related justification of the rock bottom assumption comes from evolutionary reasoning. Natural selection favours behaviour that maximizes individuals' reproductive value. Reproductive value is bounded at zero. Along these lines, Rubin & Paul (1979) argue that below the 'minimum income needed in order to support a mate and offspring' (p. 593), reproductive value is as good as zero, and hence natural selection would favour mechanisms that led to risk taking under these circumstances. when the individual received cues that their reproductive value was close to zero).

### 5.3.3 The predictions of the DTM

Having introduced the DTM, we turn to its predictions. We have mentioned two:

- Caution prediction. Individuals whose resources are only just adequate to meet their needs will show greater avoidance of risk, compared to those whose resources are abundant;
- Desperation prediction. Individuals who are unable to meet their basic needs will take greater risk,

compared to individuals who can meet their basic needs.

Though these predictions do follow from the assumptions, they are vague as stated. For example, the DTM does not predict that people just above the threshold will never take any risk. Some risks are very attractive, like a $1 ticket with a 95% chance of winning $1000. We would expect pretty much anyone to take this risk.

It is helpful to classify risky options on the basis of the average return if they were taken many times. This is the sum of the possible resource outcomes multiplied by their respective probabilities (statistically, the expected value). An 'positive-average-return' risk is one where this number is positive; if you took it many times, you would gain more than you lost. For a 'negative-average-return' risk, your long-run losses would be larger than your gains. If the mapping of monetary resources to utility were linear, it would be simple: one would take positive-average-return risks and avoid negative-average-return ones.

This helps us make the DTM predictions more specific. We define the risk premium as the amount by which the average return of a risky option has to exceed zero in order for a rational person to take it. The refined version of the caution prediction then becomes that a person whose resources are just above the threshold requires a large risk premium. The model predicts that there are some positive-average-return risks they will not take. The refined version of the desperation prediction is that a person whose resources are at rock bottom will accept a negative risk premium. The model predicts them to take all positive-average-return risks with a potential payoff large enough to move them up the cliff; but also, many negative-average-return risks, as long as these too offer some chance of jumping up.

Figure 5.2 illustrates this principle. The figure assumes a sigmoid utility function, and depicts a scenario where an individual is offered an option that will, with equal probability, yield either -100 resource units, or 100 + x resource units. We denote the risk premium with x: The risk premium converges to zero as resources pull away above the threshold. With resources just above the threshold, she needs a large positive risk premium to offset the chance of plunging below the threshold on the downside. Equivalently, she would readily pay for a safer option even if it had a lower average return. With resources just below the threshold, by contrast, she has to take risks with a negative premium, just because of the chance of returning above the threshold. She would thus be ready to pay for a riskier option, even one that will, on average, make her poorer.

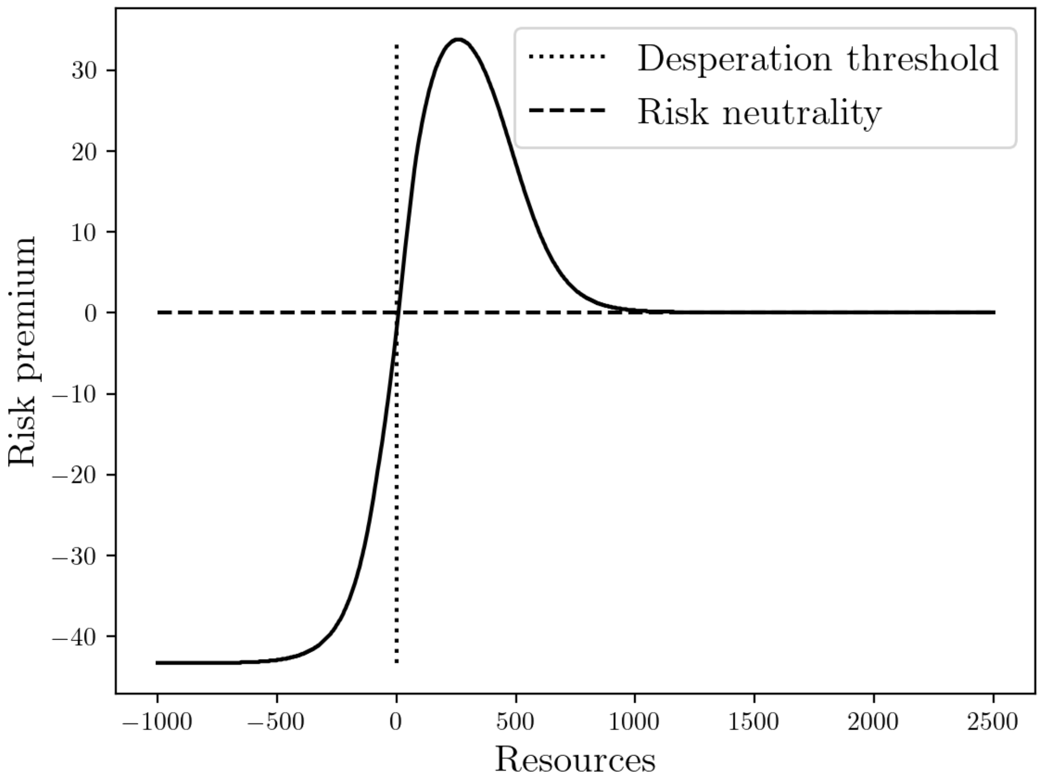


Figure 5.2: The 'risk premium', the minimum amount x that is required to make an option leading with equal probability to a payoff of -100 or 100 + x resource units worth taking, assuming a utility function combining a sigmoid function and a linear one: $U(x) = 1/(1 + exp(-x) + (x\ 0) * x/50$.

The DTM also makes a testable prediction about variation in risk taking. Let us assume the utility function underlying figure 5.2 and imagine that people's resources vary over time, at random, by up to a few hundred units. For an individual with a baseline of 2000 units of resources, these fluctuations would make absolutely no difference to which risks they were or were not prepared to take. For an individual with a baseline of 0 resource units, they would make a vast difference: with a small disturbance to their resource levels, they would go from fairly extreme risk avoidance to fairly extreme risk seeking. Thus, the model predicts that individuals whose resources are scarce should show greater intra-person temporal variability in their risk taking behaviour than individuals whose resources are abundant.

We can also state this prediction with regard to variation at the population level. Imagine that individuals vary a little in the exact position of their thresholds on the resource axis. For one person, +50 might be just above the threshold, but for another, +50 might be slightly below, because their needs and commitments are slightly different. If we are observing an affluent population all of whose resources are above 2000 units, this variation in threshold position has no consequences; such a population would be uniform in their risk behaviour. By contrast, a deprived population all of whose resources were +50 units would constitute a mixture of some people just above their thresholds and some people just below theirs. In such a population there would be a marked heterogeneity in risk taking. This leads to the variation prediction:

- Variation prediction. Populations in conditions of resource scarcity should show greater variation in risk taking than those in conditions of resource abundance, whether variation is defined within individuals over time, or between individuals.

### 5.3.4 Antecedents of the DTM

As noted, the DTM has arisen independently in several literatures, but these have remained extremely siloed. Our presentation here aims to bring the different versions together in a common format. We see four literatures as flowing directly into the DTM (though see 5.6.1 and 5.6.4 for links to further literatures that explore similar constructs, such as basic needs, thresholds, and sigmoid functions).

One literature, from microeconomics, focuses on the fact that people sometimes seek and sometimes avoid risk: they simultaneously gamble and purchase insurance. The classic works literature introduced non-monotonic utility functions and 'aspiration levels' (thresholds) to explain this (Diecidue & Van De Ven, 2008; Friedman & Savage, 1948; Robson, 1992; Roy, 1952; Simon, 1955).

A second, from agricultural economics, is concerned with why subsistence farmers are risk averse and conservative in their farming choices, assuming that they aim to avoid falling below a 'disaster level' (i.e. the caution prediction) (Chayanov, 1926; Kunreuther, 1971; Masson, 1974; Roumasset, 1971). This literature has also explored the idea that when things get really bad, a 'reswitching' to risky strategies should occur (desperation prediction).

The third literature comes from development economics. It focuses on the situation of poverty, covering both the idea that when things are at rock bottom they cannot get any worse (A. Banerjee, 2004; A. V. Banerjee & Newman, 1994), and the idea that a small extra resource can have an outsized effect, by making escape from poverty possible (Lybbert & Barrett, 2007, 2011).

Finally, an influential tradition of 'risk-sensitive foraging theory' began in animal behavioural ecology (Caraco et al., 1980; Stephens, 1981). The idea here is that starvation constitutes the ultimate threshold. When it is imminent, animals should take any level of risk to gain food (desperation prediction), whereas once it has been averted for the time being, they should avoid too much risk (caution prediction). This idea diffused from animal behavioural ecology into evolutionary anthropology and evolutionary psychology (Kuznar, 2001; Mace & Houston, 1989; Mishra & Lalumière, 2010; Pietras & Hackenberg, 2001; Rode et al., 1999; Winterhalder et al., 1999).

Whilst we acknowledge that DTM ideas are widespread, we are keen to stress that the DTM is different from the status quo in models of human decision making. Most work in microeconomics assumes that utility functions are concave across all the ranges that matter for decision making, generating mild risk aversion. This is known as Gossen's first law. The DTM is compatible with Gossen's first law across most of the resource spectrum; it merely adds that there is a convex segment brought about by the presence of a rock bottom, and that people find themselves in this segment often enough for it to matter. Non-monotonic utility functions that depart from Gossen's first law have been proposed multiple times, as mentioned above. But they have not been widely adopted in practice.

This may be in part for reasons of analytic convenience. Assuming concavity of the whole utility function is necessary to produce unique equilibria in models of agents interacting in markets. For example, it is a condition of the Arrow-Debreu model, which guarantees the existence and uniqueness of a 'general equilibrium' in a perfectly competitive economy. Assuming concave utility functions preferences may be what Cherrier (2023) called a 'tractability trap', i.e. a modelling choice made for tractability purposes that is so convenient that it becomes entrenched in the field.

### 5.3.5 The DTM and Prospect Theory

Readers may well be familiar with an existing model that features a non-monotonic value function, and which predicts a combination of risk taking and risk aversion: Prospect Theory (Kahneman & Tversky, 1979). The DTM is not, however, reducible to Prospect Theory. Indeed the two approaches do not generally tackle the same questions or make the same predictions.

Prospect Theory is a descriptive psychological theory concerning how people evaluate risky options. It was developed to capture the ways in which people appear to depart from models of perfect rationality, notably expected utility theory. It has two main components: a probability weighting function, and a value function. The probability weighting function captures cognitive biases related to probabilities: people have been observed to overweight very unlikely outcomes, and underweight very likely ones (at least when scenarios are presented by description as opposed to by experience; (Hertwig & Erev, 2009)). The value function captures the fact that valuation of outcomes is asymmetric around a reference point. That reference point is usually taken to be the status quo. Thus, people evaluate the same material change differently if it represents a loss, as opposed to a gain, relative to what they already have. They are predicted to be more risk averse for gains than for equivalent losses.

The DTM does not assume constraints on rationality, nor that people depart from maximising expected utility. Rather, it models which decisions would maximise expected utility given a utility function with the particular shape shown in figure 5.1. It does not incorporate any biases in estimating probabilities or any difference between losses and gains relative to the status quo. Under the DTM, what should drive decisions under risk is whereabouts in the resources-utility space the various possible outcomes would leave the person. Whether these outcomes represent a loss or a gain relative to the status quo is not considered. Prospect Theory-type departures from perfect rationality could also occur, but they would be deviations from the rational pattern predicted by the DTM.

Mishra et al. (2012) designed experiments in which the predictions of the DTM and those of Prospect Theory could be tested simultaneously. Participants chose between risky and riskless options to gain resources. There were two cross-factored independent variables: participants currently had (or did not have) a minimum level of resources that they needed; and the options were framed in terms of losses (or gains). The results showed both DTM and Prospect Theory effects. People chose risk more often when they were going to fall short of what they needed (the DTM's desperation prediction). They were also, collapsing across positions relative to need, more likely to choose risk when the framing was in terms of losses than gains (the Prospect Theory prediction). The need-based effect size was however considerably larger (see their figures 1 and 3). (See also Zeisberger (2022) for other evidence that people are often concerned about the probability of meeting some aspiration level in ways that are not captured by Prospect Theory).

## 5.4 Empirical evidence to date

In this section, we review the empirical evidence relevant to the DTM's predictions. We can classify the sources of evidence into four major groups, which vary on the two dimensions of causal identification and external validity (figure 5.3). Laboratory experiments are high in causal identification and low in external validity (section 5.3.1); observational studies of artificial lottery choices are low in both (section 5.3.2); observational studies of real-world decisions are low in causal identification but high in external validity (section 5.3.3); and finally natural experiments are (fairly) high in both causal identification and external validity (section 5.3.4). This typology over-simplifies. For example, some of the natural experiment studies (3.4) use artificial lottery choices, but we place them in their own quadrant because of their stronger causal design.

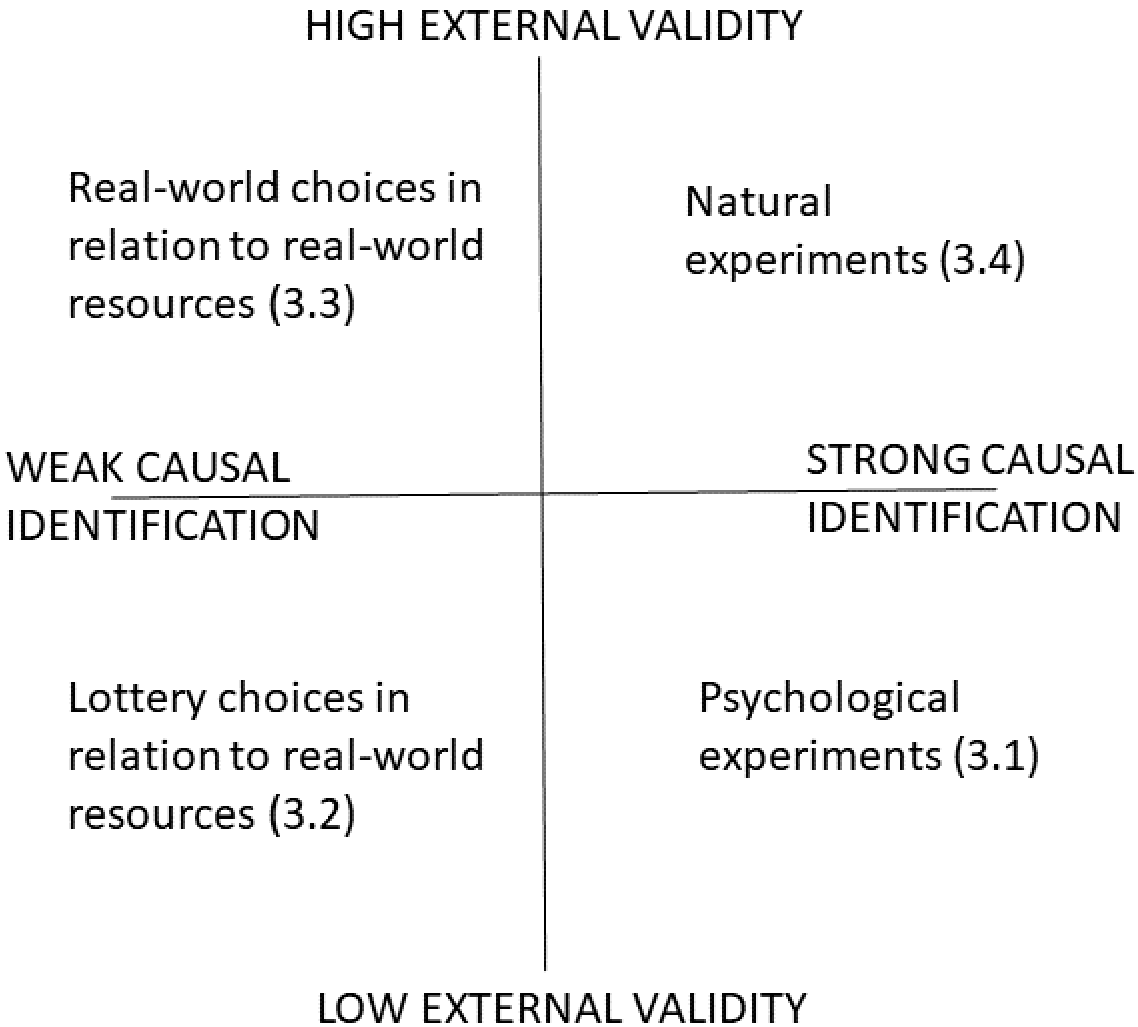


Figure 5.3: Organising classification for the sources of evidence reviewed in section 5.3. Parenthetical numbers refer to the subsections.

Our review is non-systematic, as the relevant literature is so varied as to preclude systematic review and meta-analysis. Although we have included non-supportive findings where we have encountered them, our informal search strategy will tend to bias us towards including instances that fit the narrative. Thus, the reader should consider this section as providing a guide to the diversity of evidence that can be interpreted within the framework of the DTM, not a strong falsification test. We have counted evidence as relevant where there is some test of: the desperation prediction; the desperation prediction and caution prediction jointly; or the variation prediction. A test of the caution prediction alone would not feature the DTM's hallmark feature, namely switching to risk taking at very low levels of resources.

The rest of section 5.3 only covers evidence from humans. There are also literatures that test versions of the DTM in birds (see Kacelnik & Bateson, 1996; Kacelnik & El Mouden, 2013 for reviews), bees (Cartar, 1991), and even plants (Dener et al., 2016). We refer readers to those papers for further information.

### 5.4.1 Psychological experiments

Experimental tests of DTM predictions began when researchers wondered whether ideas about risk-sensitive foraging in animals were relevant to humans (Pietras & Hackenberg, 2001; Rode et al., 1999). The varied paradigms that have been used (table 5.1) share some core features. The researcher creates an experimental currency (e.g. points or cents). An exogenous threshold level of this currency is defined, below which a negative consequence occurs (e.g. a cash payment at the end of the experiment is lost). The participant chooses between options that produce payoffs in the experimental currency and differ in their level of risk. The general finding is that participants are more likely to choose the risky option when they are not currently on target to meet the threshold requirement. Most experiments show a switch point from risk avoidance to risk taking within subjects, thus ruling out explanations in terms of stable dispositions or personality traits. The consistency of the findings is extremely high, and the effect sizes are substantial.

Most of the studies involve impersonal 'games against nature', but a subset introduces a social element. In Pietras et al. (2006), the less risky option was to share resources with another participant. In Radkani et al. (2023), the riskiest option was to steal points from other participants, with the possibility of being caught and fined. Thus, the results were a test of the DTM's ability to explain desperation-driven breakdown of cooperation, or crime.

In creating table 5.1, we excluded a number of adjacent papers that appeal to the DTM but differ methodologically from studies shown. We only included experiments in which participants made choices that could increase their (at least hypothetical) resource levels. This ruled out studies using DTM logic to investigate completely abstract or non-self-interested decision making (Mishra & Fiddick, 2012; Wang, 2002). The choices on offer had to differ in risk for amount of payoff. This meant excluding Pietras et al. (2003), where the options differed in their risk for temporal delay, rather than resource amount. It is also meant excluding several experiments such as Rode et al. (1999), where the critical choice is between options whose riskiness is known and options whose riskiness is unknown. They found that people will accept options with unknown risk more readily when their resources are below a desperation threshold. Assuming that an unknown risk feels, from a psychological point of view, like a large risk, this finding is closely related to the desperation prediction. However, it is not not identical and we have not included these studies. Finally, we excluded studies where the manipulation is purely status relative to another individual, rather than level of resources in some currency (Mishra, 2014). The DTM can be extended to explain effects of relative social status on risk-taking by assuming that 'doing as well as competitors' constitutes a basic need. However, this is an extension of the DTM rather than a test of the basic version (Deditius-Island et al., 2007) is marginal under this criterion, but we opted to include it).

Whilst the results of the experimental studies are virtually unanimous, the obvious limitations concern external validity. The experiments demonstrate that people are able to adjust their decisions as predicted when they are given, in a contrived scenario, an explicit threshold, a reason for meeting it, and a set of well-defined choices differing in risk. This is not the same as showing that their decisions outside the lab, in non-contrived scenarios, are driven by those same principles. Nonetheless, it is impressive how clearly, consistently and accurately the participants adjust their risk taking to their probability of meeting the threshold.

Table 5.1. Summary of psychological experiments testing predictions of the DTM. Ps: participants.

| **Study** | **Sample** | **Task** | **Implementation of threshold** | **Outcome variable** | **Key manipulation/comparison** | **Result** |
|---|---|---|---|---|---|---|
| Pietras & Hackenberg (2001) | 3 US adults | Pressing buttons to accumulate points | Minimum number of points required in each block of trials in order to earn money | Choice between a button with fixed yield and one with risky yield | Points requirement either small enough to meet with fixed button, or too large; within subjects | Ps favoured the fixed button when this would meet the block's requirement, and switched to the risky button when the fixed one would not |
| Pietras et al. (2006) | 4 (exp 1) + 4 (exp 2) US adults | Pressing buttons to accumulate points | Minimum number of points required in each block of trials in order to earn money | Choice between working alone, which is risky, and sharing points with another participant, which reduces risk by pooling | Points requirement either small enough to meet by sharing, or too large; within subjects | Ps favoured sharing when this led to a higher probability of meeting the points requirement, and working alone when it did not |

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|---|---|---|---|---|---|---|
| Deditius-Island et al. (2007) | 235 US undergraduate students | Computer choice task | Position relative to a fictive competitor | Choice between a fixed and a variable option | Ps assigned to be always ahead of or always behind the fictive competitor; between subjects | Ps favoured the fixed option when ahead (both sexes) and the variable option when behind (men only) |
| Pietras et al. (2008) | 8 US adults | Computer choice task | Minimum number of points required in each block of trials in order to earn money | Choice between a fixed and a variable option | Ps assigned reserves and rate of gain sufficient for the fixed option to reach threshold, or not; within subjects | Ps favoured the fixed button when this would meet the block's requirement, and switched to the risky button when the fixed one would not |
| Mishra & Lalumière (2010) | 115 Canadian undergraduate students | Computer foraging task (plus another task not discussed here) | Minimum of apples to be gathered to 'survive the week' and earn $2 | Choice between trees with same mean but different variances in apple number | Ps either close or far from meeting requirement; within subjects | The greater the probability of failing to meet requirement with low-variance tree, the greater the probability of choosing the high-variance tree. |

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|---|---|---|---|---|---|---|
| Searcy & Pietras (2011) | 10 (exp 1) + 5 (exp 2) US adults | Pressing buttons to accumulate points | Minimum number of points required in each block of trials in order to earn money | Choice between a high variance and a high variance option (fixed option in some conditions of exp. 2) | Points requirement either small enough to meet with low-variance button, or too large; within subjects | Participants favoured the high variance option when the low variance option had a low probability of meeting requirement |
| Mishra et al. (2012) | 50 (exp 1) + 84 (exp 2) Canadian undergraduate students | Exp 1B: Computer foraging task (plus another task not discussed here). Exp 2: Hypothetical investment task | Exp 1B: Minimum number of apples/points to be paid for experiment. Exp 2: Imaginary debt that needs to be paid off. | Exp 1B: Choice between trees with same mean but different variances in apple number. Exp 2: Choice between a higher risk and low risk hypothetical investment option | Exp 1B: Ps either close or far from meeting requirement; within subjects. Exp 2: Hypothetical debt either small enough or too large to be paid off with less risky investment option; within-subjects. | Exp 1B: More choice of high-variance tree when far from meeting requirement. Exp 3: More choice of risky option when debt too large to be paid off with safe option. |

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|---|---|---|---|---|---|---|
| Bennett & Pietras (2021) | 5 (exp 1) + 8 (exp 2) US adults | Pressing buttons to accumulate points | Minimum number of points required in each block of trials in order to earn money | Choice between fixed and risk option (exp 1) or lower and higher risk option (exp 2) | Per trial 'energy cost' in points that either made it either possible or impossible to meet the minimum requirement using the fixed/lower-risk option; within-subjects | Fewer choices of fixed option (exp 1) or low-risk option (exp 2) when energy cost was high |

| | | | | | |
|---|---|---|---|---|---|
| Radkani et al. (2023) | Computer cooperation task | Minimum number of points required in order to access a cash bonus | Choice between working alone (no risk but unprofitable); cooperation (slightly profitable and slightly risk); or stealing from other players (highly profitable but highly risky) | Exps 1-3: Whether current points level was above minimum requirement; within subjects. Exp 4: Whether initial points level was above minimum requirement; between subjects. | Stealing more common when points level below the minimum requirement (all exps). Control conditions rule out alternative explanations (exps 2 and 3). High inequality in group produces more stealing if it entails that some players are below minimum requirement (exp 4). |

### 5.4.2 Choice tasks in relation to real-world resources

This section concerns observational studies that use participants' real-world resources (for example, their income or wealth) to predict their choices on artificial dilemmas involving risk (table 5.2). The dilemmas are typically expressed as choices between gambles, such as 'Would you prefer $100 for certain, or a 50% chance of getting zero and a 50% chance of getting $200?'. The currency of the payoffs and the size of the stakes varies across studies. In some studies, the gambles are paid out; in others, hypothetical.

We excluded studies that aim to establish whether people in a certain population are risk averse on average, and those that test only for monotonic relationships between resources and risk taking. Such studies are numerous, both of large datasets from mostly high-income countries (Dohmen et al., 2011; Donkers et al., 2001; Eckel et al., 2012; Guiso & Paiella, 2008) and smaller samples from rural subsistence contexts (Miyata, 2003; Wik et al., 2004). The typical finding is that risk taking increases with income and wealth, supporting the caution prediction. However, since the distinctive prediction of the DTM is the desperation prediction, the minimum criterion for inclusion in table 5.2 was either a comparison of individuals who could not meet their basic needs with individuals who could, or some kind of test for non-monotonicity.

The studies in table 5.2 all find some evidence for the desperation prediction. One study, de Courson, Frankenhuis, & Nettle (2025), also tested the variation prediction. Populations studied range from farmers and herders for whom starvation is a serious possibility, through to people in contemporary France, the UK and USA, where this is presumably not the case. Some of the studies defined what the threshold point should be a priori. For example, Caballero (2010) calculated what income would be needed in Bogota to avoid malnourishment. Others used the data to identify an inflection point, for example by using curvilinear or broken-stick regression. Some studies used subjective rather than objective resources variables (de Courson, Frankenhuis, & Nettle, 2025; e.g. Tucker, 2012). That is, rather than measuring material assets, they used the participants' appraisals of whether they had enough to meet their basic needs as the predictor.

Though the predictor variable in these studies is ecologically valid, the outcome variable is not spontaneous decision-making. Where the dilemmas are incentivized, the stakes are necessarily small or moderate (up to a few days' wages). The studies that have deliberately made the stakes large enough to have life-changing consequences have, perhaps necessarily, used hypothetical incentives. Kahneman & Tversky (1979) defend the use of hypothetical dilemmas for such problems, given the ethical and practical impossibility of making such stakes real, and on the basis that it is reasonable to assume that people know how they would behave, and have no special reason to disguise their inclinations (p. 265). Holt & Laury (2002) show that choices in incentivized and hypothetical risk dilemmas follow a similar pattern, although as the stakes increase, people become more risk averse for the incentivized case than the hypothetical one.

Table 5.2. Summary of choice-task studies relevant to the DTM.

| **Study** | **Sample** | **Resource measure** | **Risk measure** | **Result** |
|---|---|---|---|---|
| Dillon & Scandizzo (1978) | 130 Brazilian small farmers | Tenure (farm owner vs. sharecropper); risky prospect (worst case outcome yields enough for subsistence or not) | Hypothetical gambles over different farm yields | Sharecroppers (poorer) took more risks than owners (more affluent); within groups, people with higher income took more risks; less risk taking when subsistence at risk than when not |

| | | | | |
|---|---|---|---|---|
| Barsky et al. (1997) | 11,000 US adults | Income and wealth | Hypothetical gambles with large stakes (up to doubling lifetime income) | U-shaped relationship with more risk taking by people in the lowest and the highest quintiles of income and wealth than the middle |
| Caballero (2010) | 87 adults from Colombia | Having sufficient income to avoid malnourishment, or not | Incentivised gambles with moderate stakes (up to 23% of participants' monthly wage) | More risk taking/less risk aversion for participants just below the nutritional threshold |
| Kuznar (2001) | 23 adult Andean herders | Wealth in terms of livestock herd value | Hypothetical gambles with large stakes (in the currency of livestock) | Curvilinear relationship between wealth and risk taking, with high risk taking among the poorest and richest herders |
| Tucker (2012) | 340 rural Madagascan adults | Food security (being able to consistently access adequate food) | Incentivised gambles worth up to a day's labour equivalent | More risk taking by food insecure participants, taking into account large number of other ethnic, village and economic predictors |
| Maertens et al. (2014) | 206 Indian farmers | Total household wealth | Hypothetical gambles with large stakes (in the currency of cotton yield) | U-shaped relationship with more risk taking by members of poorest and richest households |

| | | | | |
|---|---|---|---|---|
| de Courson, Frankenhuis, & Nettle (2025) | 232 French and 240 UK adults, repeatedly assessed over one year | Subjective perception of adequacy of resources, plus objective ratio of monthly income to monthly essential costs, plus ancillary measures of resource adequacy. | Hypothetical gambles with medium stakes (payoffs of up to 800 euro) | The most extreme risk takers and the most extreme risk avoiders had lower resources than the intermediate risk takers; people with lower resources showed more variability in their risk taking; evidence for a broken-stick relationship between subjective resources and risk taking (negative relationship to a certain point, then positive relationship) |

### 5.4.3 Real-world choices in relation to real-world resources

This section reviews observational studies of real-world decisions between alternatives that differ in risk, in relation to real-world resource levels (income or wealth). We opt for a narrative approach rather than a table, and concentrate on two sets of studies: of subsistence strategies (3.3.1), and of acquisitive crime (section 5.3.3.2). The strength of these studies is the external validity of the outcome measure: they measure what people actually do to try to make their living. On the other hand, as for the studies in 3.2, the causal identification is weak.

#### 5.4.3.1 Subsistence strategies

Subsistence strategies are a suitable domain in which to test the DTM's predictions. Resource levels can be well quantified, for example using acreage or herd size. Producers constantly have to decide between different options, for instance between consumption crops and cash crops (Kunreuther, 1971), or between drought-resistant camels and drought-susceptible goats (Mace, 1990). These options vary in risk in ways that can be estimated empirically from available data.

Kunreuther & Wright (1974) examined the behaviour of farmers in 20th century Bangladesh and the 19th century US South. In both cases, the farmers had to choose between a consumption crop (rice/corn) and a crop for cash sale (jute/cotton). Those choosing the cash crop would mostly use the cash to buy the consumption crop at market. Producing the cash crop is riskier due to the vagaries of market prices: the year-to-year standard deviation in the amount of food a farmer could end up with was 2-3 times higher (Bangladesh) or 4-5 times higher (US South) if they chose to plant the cash crop. On the other hand, the mean amount was also often higher. In both locations, those with large farms planted a greater proportion of their fields with cash crops than those with moderate-sized farms (caution prediction). However, among the very smallest farms, the trend reversed, and the farmers went for a high proportion of cash crops (desperation prediction). Kunreuther and Wright commented 'one possible explanation would be that the farmer has a utility function which decreases sharply at some critical income level, so that he prefers to gamble to avoid poverty' (p. 3).

Mace (Mace, 1990; Mace & Houston, 1989) studied the choice by African herders to keep sheep and goats versus camels. Camels can better tolerate drought conditions, and hence are less risky, but less profitable. In a theoretical model, Mace & Houston (1989) showed that very poor households should keep only sheep and goats, to get their herds to a critical size. Above this size, they should buy safer camels, which should then be the bulk of their herds. This prediction was clearly supported in three groups studied, and ambiguous in a fourth (Mace, 1990). Households with a small herd kept exclusively sheep and goats (desperation prediction), whilst households with large herds kept mostly camels (caution prediction).

#### 5.4.3.2 Property crime

Property crime as a high-risk way of gaining resources compared to legitimate economic activity. It necessarily involves the risk of being caught and punished, not to mention the payoffs being highly variable for other reasons. Making risky choices in artificial risk dilemmas predicts criminal behaviour in young men, even after controlling for other factors (Epper et al., 2022). The DTM thus predicts an increased probability of turning to acquisitive crime when resources are extremely low (desperation prediction). There is some criminological evidence compatible with this prediction (which was tested experimentally in Radkani et al. (2023), see section 5.3.1).

McCarthy & Hagan (1992) found that the best predictor of theft among homeless Canadian youth was hunger. More generally, property crime rates are higher in poor neighbourhoods (Patterson, 1991) and in periods of high unemployment (Levitt, 2001). Extremely disadvantaged neighbourhoods, where desperation is presumably more frequent, display 'unusually high rates of crimes' (Krivo & Peterson, 1996; W. J. Wilson, 2012), even though most individuals there avoid crime. In a study of bank robbers, Camp (1968) explicitly explained the robberies by a "nothing to lose" feeling. Shover (1996), in a study of individuals who committed theft that, 'all their lives most have been poor or just a financial crisis and a few paychecks away from it' (p. 30). Jacobs & Wright (1999) reported that 'with few exceptions, the decision to commit a robbery arises in the face of.....a pressing need for fast cash' (p. 153), often linked to their ability to secure basic necessities. Rossmo & Summers (2022) found that many respondents distinguished offending based on 'wants' from offending based on 'needs'. The authors coined the concept of 'quantum jumps' in subjective utility, which can trigger offending. The quantum jump captures our notion of a threshold. A quantum jump exists when someone 'needs a specific amount of money such that anything less has limited value; for example, a person who has a debt with an impending payment due or must come up with the rent in order to avoid eviction. For these individuals, it is a matter of all or nothing' (p.7).

### 5.4.4 Natural experiments

This section deals with cases with studies where there is some shock to, or exogenous driver of, resource levels. This allows researchers to measure subsequent variation in risk taking with moderate confidence that changes in resource levels are the causal factor. The strength of these studies is that many third-variable and reverse causality explanations can be ruled out. There are two kinds of relevant study: resource shock studies, and resource cycle studies.

Resource shock studies examine the consequences of exposure to natural disasters or civil upheaval for risk taking, usually measured with artificial risk dilemmas. These studies find sometimes that exposure increases risk taking (Eckel et al., 2009; Hanaoka et al., 2018; Kettlewell et al., 2024; Page et al., 2014), and sometimes that it decreases it (Callen et al., 2014; Cassar et al., 2017). Many of these studies are difficult to relate directly to the DTM. Their independent variable is some measure of exposure to the shock. The researchers are mostly interested in identifying the psychological impact of exposure, but it is not clear whether or how the respondents' objective resource levels were altered, or whether they have been restored by the time of study. An exception is the study by Page et al. (2014), who studied an unexpected Australian flood. They examined risk taking by homeowners with large property losses compared to neighbours whose houses happened to be a little way above the waterline. The homeowners with losses took more risk in a gambling task, and the worse the losses, the more likely they were to choose the risky options.

Resource cycle studies use exogenous temporal variation in resource levels to identify their causal impact. The classic example is the welfare check cycle: in jurisdictions where welfare payments are made around the 1st of the month, the day of the calendar month serves as an instrumental variable for people's current resource levels. Foley (2011) found that in US cities where welfare payments are concentrated at the beginning of the month, acquisitive crimes follow 'welfare payment cycles', with an increase in the rates over the course of the month as welfare payments run out. Akesaka et al. (2023) studied artificial risk dilemmas in American and Japanese samples who depended on a monthly payout. In both cases, risk taking increased in the period leading to the pay day. An oddity of these results is that the gambles had lifetime consequences and extremely large stakes. If the actual resource shortfall is a minor one that will only last a few days, it is unclear why, under strict rationality, preferences for long-term decisions ought to change. The best interpretation here is that falling short of a need level induces a risk taking mindset, which then gets applied generally, both to decisions that are strategically appropriate to solving the problem, and to decisions that are not. We note also that Carvalho et al. (2016) did not find any difference in weakly-incentivized gamble risk taking before versus after payday in two panels of relatively low-income US adults.

In the context of the DTM, many of these studies suffer from a problem of prediction specificity: what does the model actually predict in these cases? The DTM predicts a non-monotonic mapping of risk taking to resources. A negative shock could thus either increase or decrease risk taking, depending on where in relation to the threshold the person started out, and the magnitude of the shock. At least one of these is usually unknown. The fact that resource shock studies sometimes find increases in risk taking and sometimes decreases makes sense in the context of the DTM, but it causes an epistemological problem. If both an increase or a decrease in risk taking could be counted as support for the DTM, then how could the DTM ever be falsified? We return to this question in section 5.5.3.

## 5.5 Population consequences of the DTM

The DTM is a model of individual decision making, but it can be used to predict and interpret patterns at the levels of populations and societies. Thus, it has potential to contribute to solving the 'micro-macro' problem in social science. This is the challenge of linking individual-level actions and decisions to broader societal patterns (Coleman, 1990; Elster, 2007; J. M. Epstein, 2012). Inference between the DTM and population-level patterns is potentially bidirectional. On the one hand, one can assume the DTM is true at the individual level in order to make predictions about regularities at the societal level [de Courson & Nettle (2021), see 4.1). On the other hand, patterns observed at the societal level can provide evidence that the DTM is a realistic model of how the individuals in those societies are making decisions (see 4.2). This seems rather circular: we assume that the DTM is true in order to understand macro-patterns, and use macro-patterns as evidence that the DTM is true. In fact, this is just an example of 'inference to the best explanation' (P. Lipton, 2017). The more varied the phenomena that turn out to be concordant with the DTM, the stronger the case that it is a useful idealization.

### 5.5.1 Explaining associations between inequality and aggregate outcomes

Many studies have detected correlations, across cities, countries or states, between the inequality of the income or wealth distribution (as measured with the Gini index), and aggregate outcome variables such as average life satisfaction, average health, crime rate, or average social trust (Barone & Mocetti, 2016; Kelly, 2000; Rufrancos et al., 2013; R. G. Wilkinson & Pickett, 2009). This has led to considerable debate about causality (Lynch et al., 2004; Nettle & Dickins, 2022; Sommet et al., 2018; Truesdale & Jencks, 2016; Vilalta et al., 2024). The Gini index is an abstract population statistic. It is unclear by what causal pathway it could affect the health, emotions or decisions of individual people.

One simple way that greater inequality in the resource distribution can affect aggregate outcomes is if the mapping between resources and outcomes at the individual level is non-linear. For example, imagine that the probability of committing an acquisitive crime rises sharply when individuals have less than $1000, and is a flat line for all incomes greater than that. If the income distribution is made more unequal (keeping its mean in the same place), then more people than before will have less than $1000, and their probability of committing crimes will go up. There will also be people who have got richer by a corresponding amount, but their probability of committing crimes won't go down, because the resources-crime function is flat at the higher end. So, the people who are made worse off will commit more crimes, and the people who are made better off will not commit any fewer. The total amount of crime goes up. This is known as a concavity effect (Gravelle, 1998). Due to the non-linear mapping at the individual level, the aggregate outcome is affected by changes in not just the mean, but also the variance, of the resource distribution.

Because the DTM predicts a non-linear mapping between individual resources and decisions, it implies that concavity effects will be widespread, and thus that inequality will often matter (statistically) for aggregate outcomes. Concavity effects follow by mathematical necessity. They do not rely on the people in the population having any particular reaction to inequality per se, or even perceiving it. Much of the debate in the inequality literature concerns whether concavity effects are sufficient to explain associations between inequality and aggregate outcomes, or whether other processes must also be at work (Daly, 2023; Kelley & Evans, 2017; Nettle & Dickins, 2022; Sommet & Elliot, 2023).

It may be helpful in this context to distinguish between primary effects of concavity, and secondary effects, which are due to people responding to the primary effects. de Courson et al. (2023) argued that greater acquisitive crime may be a primary effect of increased desperation as inequality becomes larger; it is committed largely by individuals who find themselves below the desperation threshold. Decreased social trust and increased violent crime may be secondary effects. People find themselves in a population in which others may try to steal from them. Hence, they trust less; and they may also need to use violence as a toughness signal, to avoid being the target of stealing. Secondary effects need not be restricted to individuals who are below the desperation threshold. In a population in which more people are desperate, the lower trust could become general through interaction.

If associations between inequality and aggregate outcomes are driven by concavity effects and their secondary consequences, then there is a sense in which inequality is not the real causal variable. The real causal variable is the fraction of people who are below the threshold (de Courson & Nettle, 2021). Across many scenarios, the Gini and the fraction of people who are below the threshold are perfectly correlated. However, there are thought experiments in which the two are decoupled. For example, the DTM predicts that in a society so rich or so well institutionally protected that every individual's basic needs were guaranteed always to be met, the Gini coefficient should cease to predict aggregate outcomes. A second thought experiment is that in a society where almost everyone's resources were below the threshold, the DTM predicts that increasing inequality could improve aggregate outcomes. This would be because broadening the dispersion would put some individuals into above-threshold positions, whilst the bulk of people, already being below the threshold, cannot be made much worse off than they already are.

### 5.5.2 Impact of welfare states on risky behaviours

Economically advanced countries have welfare states that function to boost low incomes, and prevent them ever becoming critically low. In principle, in a perfectly effective welfare state, there would be no fear of falling below the threshold, and zero incidence of actually doing so. This means we should not observe either the extreme caution characteristic of people just above, nor the desperate risk taking of people below, in a society with such a system.

A few cross-national studies have examined the effect of welfare provision on risk taking. Bird (2001) showed that where there is a more generous welfare provision, people take on economic activities with more variable income streams such as entrepreneurship. Likewise, Iversen & Soskice (2001) found that in countries where people take on more training for highly specialised trades, there is higher public support for welfare provision. The researchers argue that trade specialisation is a risky investment, so where it is common, people want insurance against the downsides. The direction of causality cannot be unambiguously identified in these studies: it could be that where people's incomes are more variable, they vote for welfare expansion; or where there is good welfare, they take on risky jobs. Schroyen & Aarbu (2018) compared risky choices, measured using artificial risk dilemmas, across six countries. People in countries with more extensive welfare provision chose more risky options. In DTM terms, this can be interpreted as a reduction in above-threshold caution that comes from knowledge that there is an effective safety net.

If the welfare state effectively prevents people from falling below the threshold, then better welfare prediction should reduce crime. The hypothesis that welfare provision suppresses crime is over 125 years old, with Franz von Liszt describing social policy as 'the best and most effective crime policy' in 1898 (cited in Rudolph & Starke (2020)). Rudolph & Starke (2020) reviewed 41 cross-national studies testing the hypothesis that more generous welfare provision is associated with lower crime rates. Thirty-two studies, plus the original study they present, found support for the hypothesis. In their own data, the strongest welfare-provision predictor of a lower crime rate (operationalised as homicide rate) was the generosity of unemployment insurance. They argue that unemployment insurance insulates people from the extreme strain of loss of livelihood. Relatedly, Calnitsky & Gonalons-Pons (2021) found that, in an experimental trial of a guaranteed basic income scheme (the Manitoba Basic Annual Income Experiment), the intervention reduced both property crime and violent crime.

In summary, correlates of more generous welfare provision appear to include both increased risk taking (for socially benign risks such as choice of profession), and decreased extreme risk taking (such as property and violent crime). The DTM provides micro-foundations through which these two seemingly contrary effects could both occur. The positive effects of better welfare institutions on risk judgments has been used as a central argument for investing in more generous and universal welfare systems (Johnson et al., 2025).

### 5.5.3 Deterrence of crime

Since Beccaria (1764) and Bentham (1789), one of the main justifications for the penal system punishing people has been that fear of punishment should deter crime. Implicitly, this argument is based on expected utility: if individuals balance costs and benefits, authorities could prevent crime by imposing sanctions harsh enough to make the payoff negative on average (Becker 1968). Making the punishment more severe may be easier and cheaper than increasing the probability of punishment, and should be as effective if individuals were indifferent to risk (since expected utility is the product of the probability of the sanction and its size). However, in empirical studies, there is little evidence that increasing punishment severity has a negative effect on crime rates, while the effect of the probability of sanction is clear (Barnum & Nagin, 2023; Dölling et al., 2009; Nagin, 2013).

The DTM can potentially explain why increasing severity is apparently not deterrent (whilst improving welfare provision is, see section 5.4.2). Assuming that much crime is committed by individuals with below-threshold resources, the perpetrators are typically at or close to rock bottom. A larger punishment then has no greater effect on them than a smaller one. What matters is that the deviant act gives them some probability of moving back above the threshold. A formal model by de Courson & Nettle (2021), based on the DTM, predicted that increasing punishment severity beyond a minimal level would not reduce property crime, since this was only ever committed (under the assumptions of their model) by people already at rock bottom anyway. The model even predicted some circumstances in which more severe punishment could make property crime more prevalent: very severe punishments push temporarily desperate individuals further into desperation, hence in the direction of subsequent crime. This prediction - of increasing punishment severity sometimes being not just ineffective but counterproductive - was made independently in a theoretical paper using similar assumptions to the DTM (W. B. MacLeod, n.d.).

## 5.6 Critical issues

In our presentation thus far, we have left some important conceptual and epistemological issues unaddressed. Resolving these is important for identifying more precisely the predictions of the model and ascertaining its scientific value.

### 5.6.1 Is the threshold a subjective or objective construct?

The first question is whether the input variable to the DTM - the level of resources - should be interpreted in objective material terms (e.g. a number of dollars or calories) or subjective psychological ones (a feeling of basic needs being met). Our answer to this question is both. The subjective feeling that needs are, or are not, being met should be a strong proximal determinant of either taking or avoiding risks. However, we would expect objective resource availability, in turn, to influence these subjective feelings. Hence the DTM is relevant to people who want to study the consequences of changes in objective economic resources and their distribution.

The effect of changing material resources should be mediated by changes in subjective feelings. In a straightforward comparison, the subjective variables should often be the stronger predictors, as they are closer in the causal chain. Different people need different levels of objective resources to achieve the same level of security, so dollar or euro incomes are noisy measures of desperation. However, people are presumably good at taking a 'read' of their situation, and so subjective measures may be less noisy. In many domains, subjective appraisal variables turn out to be good predictors of future outcomes, outperforming more objective indicators (Idler & Benyamini, 1997). In a recent study, de Courson, Frankenhuis, & Nettle (2025) used both a subjective resource adequacy measure and an objective measure of household income to predict risky choice. The hallmark DTM pattern of risk avoidance at low resource levels, and risk taking at very low resource levels, was more clearly supported with the subjective appraisal measure.

### 5.6.2 Is the threshold level absolute or relative?

Another question is whether the threshold level is absolute or relative, that is, to what extent its position depends on others' levels of resources. Both perspectives are defensible. Hunger does not intrinsically depend on what other people have to eat. On the other hand, what is considered a basic need clearly varies over time and space, depending on what it is normal to have in a society: as Marx (1849) observed, "let there arise next to the little house a palace, and the little house shrinks to a hut" (p. 16).

We leave this question somewhat open, but we are unattracted by either extreme position. A purely absolute conception of threshold level is clearly problematic. The threshold of desperation is a level of material resources that allows people to satisfy the basic needs constituted both by their physiology (which are largely absolute), and by the expectations and social roles available in the broader society (which must have a relative component). It surely differs between a hunter-gatherer society and an industrial market society. We have already mentioned (section 5.2.2) Adam Smith's observation that necessities include whatever it is "indecent for creditable people to be without". This is necessarily society-relative.

On the other hand, if the position of the threshold were purely relative, then uniform increase in society's wealth (affecting all percentiles of the distribution in the same way) would have no impact on the prevalence of desperation. Yet there have been directional historical reductions in many important risk-related behaviours, such as violence, as societies have become more affluent (Baumard, 2019; Pinker, 2012; Thome, 2007). We are interested in using the DTM to understand these changes. It seems unreasonable not to acknowledge that the overall growth in society's wealth has decreased the amount of desperation.

We favour a hybrid position. We know that as people's individual incomes increase, their idea of the level of income necessary to meet basic needs also increases. But it only increases about half as fast as their incomes. Thus, as they get richer, their individual subjective threshold rises, but they also perceive themselves to be further from it. We suspect something similar can happen at the societal level. As the people around us obtain more, our notion of what is indecent to be without does change, but not necessarily at the same rate. Thus, there is scope for societies to differ sharply in the prevalence of desperation.

### 5.6.3 Is the DTM falsifiable?

In many datasets, it is hard to know a priori where on the resource scale the cliff and the rock bottom are located. This makes the DTM able to accommodate a variety of patterns without its predictions being clearly falsified. If the observed association between resources and risk taking is linear and negative, we could conclude that the DTM is supported, but there are no desperate individuals in the sample. If the association is U-shaped, we would definitely conclude that the DTM is supported. There can also be an apparent circularity: we identify those individuals who are below the threshold because they take risks, and also explain that risk taking by the fact they are below the threshold. Thus, the model could be accused of being so permissive and hermetic that it is essentially unfalsifiable.

We defend the DTM against this charge. The above criticisms apply mainly to observational studies relating some measure of objective resources to some measure of risk taking. Even for these studies, there are many patterns that would falsify DTM predictions, for example no association, or an inverted U-shape with the highest risk taking in the middle of the resource distribution. More importantly, studies of this type form only one part of the evidence supporting the DTM (section 5.3). Studies that use subjective appraisals of whether people feel their needs to be met make stronger predictions: a switch to risk taking around the point where the participants feel unable to to meet their basic needs. The experimental studies are also important, despite the ecological validity concerns, because the predictions are unambiguous and the causality clear.

The DTM is a middle-range theory. A middle range theory is not usually falsified by any individual data set or experiment (Ketelaar & Ellis, 2000). Applying a middle range theory to any particular empirical setting always requires additional contextual understanding. Middle-range theories prove their value by generating useful understanding over many different local contexts, and their ability to unify diverse observations. This is why we have stressed the diversity of relevant evidence in section 5.3, and the DTM's ability to illuminate population-level phenomena in section 5.4. A middle-range theory like the DTM should be discarded if it fails to give rise to a generative research programme, where generativity is assessed by: connection of diverse phenomena; production of avenues for enquiry; and capacity for progressive refinement by data whilst retaining a core set of assumptions (Lakatos, 1963). Our contention is that the DTM could lie at the core of a generative research programme in this sense; though of course, only time will tell.

## 5.7 An agenda for DTM research

In this final, non-exhaustive section, we outline possible areas for the growth of future research inspired by the DTM.

### 5.7.1 Proximal representations: thresholds in the mind

The DTM posits that people's utility functions have a particular shape (see figure 5.1A). This could be taken in an 'as if' sense: people behave 'as if' their decisions were driven by maximisation of a function of this shape. But there must be underlying cognitive computations or heuristics that deliver the predicted pattern of choices. Two literatures we are aware of have attempted to directly measure the shape of utility functions in the mind. Interestingly, they both posit sigmoid functions resembling figure 5.1A.

The first, the individual welfare function literature of the 1970s and 1980s, used survey data in which respondents stated what levels of income they would consider 'very bad', 'bad'...'good', or 'excellent' (Kapteyn & Wansbeek, 1985; Van Praag, 1971). The 'very bad' income level was assumed to carry a utility of zero, and the 'excellent' a utility of one; the income values given for the other descriptors were used to estimate the shape of the function across the interval in between. Though the resulting function was sigmoid, this was largely due to the assumptions made. Moreover, a logarithmic function, which would satisfy Gossen's first law but not the DTM, fitted the data almost as well (Van Herwaarden & Kapteyn, 1981). In short, this paradigm was hampered by a number of assumptions (such as that a 'very bad' income is the worst possible income someone could imagine) and limitations (such as fitting non-linear functions to just nine points per respondent). We do however feel that the objective was important and that the limitations could be addressed in future research.

The second literature comes from neuroscience, where researchers have estimated the shape of utility functions for sweet juice in monkeys (Genest et al., 2016; Stauffer et al., 2014). The functions are sigmoid, and the magnitude of response to reward cues in midbrain dopamine neurons also reflects the sigmoid shape. The paradigm uses choices under risk to infer the shape of the function. In other words, the researchers used the fact that the monkeys are risk prone for small rewards and risk averse for large ones to back out the sigmoid shape, rather than observing the sigmoid shape first and then predicting risky choices from it. Nonetheless, we would like to see this approach extended to humans and the reward domain of income or wealth.

### 5.7.2 The connection to wellbeing and poverty research

There is considerable epidemiological research associating measures of subjective wellbeing and mental health to levels of actual financial resources (Nettle, Chevallier, et al., 2025; Nettle & Dickins, 2022). Whether we should expect these associations to be sigmoid (indeed, whether the DTM predicts that they should be) depends on the extent to which we see subjective wellbeing (or mental health) measures as capturing the same thing as utility.

All accounts of the resources-wellbeing mapping feature the cliff, because they all include diminishing marginal returns, usually by assuming a logarithmic relationship. However, wellbeing research has not, to our knowledge, demonstrated the existence of rock bottom. This may in part be due to methodological choices: fitting a monotonic function, such as a logarithmic one, precludes the detection of non-monotonic mappings. Alternatives such as 'broken-stick' regression (as used in de Courson, Frankenhuis, & Nettle, 2025) allows the investigation of non-monotonicity.

Another relevant literature links financial resources to material deprivation. A material deprivation is the inability, for financial reasons, to achieve a key objective. Examples are: keeping one's home warm; having adequate and substantial meals; replacing worn-out furniture; buying new clothes; and being able to meet friends and family at least once a month. These objectives are chosen so as to represent 'the goods and services necessary to lead a decent life' (Blasco, 2023, p. 7). As such they correspond closely to the notion of basic needs we developed in section 5.2.2.

Empirical research across multiple European countries shows that the relationship between income and the number of material deprivations is non-linear, with three regimes (Blasco, 2023). Between incomes of

0 and around half the median income, the relationship between income and the number of deprivations is a flat line. Between around 0.5 and 1.5 times the median income, there is a steep negative relationship; each increment of extra income reduces the number of deprivations. Above 1.5 times median income, there is again a flat line, because the number of deprivations is typically zero.

This looks very like what the DTM requires: at rock bottom, small increments in income are insufficient to make any difference to deprivations. Around the cliff level, extra resources rapidly reduce deprivations, and this flattens off once all deprivations are gone. However, the interpretation of the pattern by Blasco (2023) is more methodological than substantive. He argues that the flat relationship between income and deprivations below 0.5 times the median income is that people with incomes this low are very heterogeneous. Some may be living off capital or support from family. Thus, the incomes people report in this bottom part of the distribution are simply a poor guide to their actual resources, rather than any deeper discovery about rock bottom. Nonetheless, we view the research on material deprivations as highly relevant to the DTM and an area for future DTM-inspired research.

### 5.7.3 Moral and ethical thought

There is a cluster of moral and ethical questions, some of them empirical, some normative, concerning basic needs and distributive justice. We believe these connect to the DTM, and in some cases tacitly assume the DTM utility function pattern, but we would like to see the connections explored explicitly.

Empirically, participants sometimes find distribution on the basis of effort or merit to be morally just (even if this leads to inequality), and sometimes find unconditional distribution of resources to all group members to be morally required (Nettle & Saxe, 2020; Starmans et al., 2017). The difference-maker between these two cases may be whether the putative recipients are perceived as being above or below the basic needs cliff. The psychology of sharing is highly sensitive to cues of need (Lightner et al., 2023). Relatedly, participants tend to have 'quasi-maximin' preferences for social distributions (Kameda et al., 2016; Nettle, Chrisp, et al., 2025). That is, they place great weight on how good or bad the distribution is for the worst-off participants. This implies, in effect, that there are representations of others' need functions, and of a threshold, available during moral computation.

Notions of cliffs and thresholds also crop up in normative reasoning. The philosophical position of sufficientarianism holds that justice requires that everyone has 'enough'. This requires a definition of 'enough', and a threshold where 'enough' has been reached. Many political philosophers have argued that society should protect people from being unable to meet their basic needs through no fault of their own. The grounds for this requirement are varied: the utilitarian (being below the threshold is disproportionately unpleasant, and so eliminating this possibility is an efficient way of increasing aggregate wellbeing (Singer, 2009)); the contractarian (if people decided on a social order under a veil of ignorance about what position in society they would occupy, they would prefer one in which there was no chance they would find themselves below the threshold (Rawls, 1971)); and the liberal (people below the threshold are vulnerable to arbitrary domination by other people, so ensuring no-one is in the position maximises freedom; (Pettit, 2014)). All versions tacitly require that something like the DTM pattern exists: that there is a level of resources it is disastrous to be without, so that attaining and maintaining this level has a moral priority over other kinds of claim (see Wiggins, 1998).

In modern states, the welfare system is the set of institutions that addresses the moral claims of need. Although normative justifications for welfare systems vary, it is often said that they should 'put a floor under people's feet' or 'protect people from the worst outcomes'. In more explicitly DTM terms, we could see welfare systems as (ideally) insulating people from any danger of falling down the cliff, and hence removing any need for them to ever be excessively risk averse, or irresponsibly risk prone (see 4.2).

### 5.7.4 Sociopolitical implications

Societies generate 'moral orders', sets of stable expectations about what resources people will be entitled to. A long-standing puzzle in social science is the fact that people who are relatively disadvantaged by these moral orders often nonetheless comply with them, and even justify them (Jost et al., 2004). On the other hand, moral orders can collapse quite rapidly in episodes of social flux and rebellion. Predicting these episodes is difficult, and is the topic of longstanding enquiry (Gurr, 2015; e.g. Turchin et al., 2017).

The DTM may shed some light on the combination of frequent compliance and occasional rebellion. If an order provides people a very high probability of meeting basic needs, the DTM predicts risk aversion. People who are currently above the threshold will prefer a fairly bad status quo to the huge risk involved in a rebellion. However, once the moral order fails to satisfy the basic needs of enough people (or seems likely to do so in the near future) then the DTM predicts a widespread turn to risk taking (for relevant evidence, see Humphreys & Weinstein, 2008). It is then that rapid social flux becomes more probable.

Political elites can predict that the populace will remain more or less compliant as long as their basic needs are met. Indeed, elites have an incentive to maintain the populace just above the threshold, where they are maximally risk averse. We should expect elites to put in place institutions just generous enough to allow most people to guarantee basic needs, but not more generous (Juvenal's famous 'bread and circuses'). This implies that societies may exhibit 'self-organised criticality' (Bak et al., 1988): they will spend most of their time close to a tipping point, where a relatively small subsistence shock could lead to sociopolitical upheaval.

A case study comes from the work of Scott (1977) on peasants in Southeast Asia, who considered their ability to secure their subsistence as their central "moral claim" (p.32). Their criterion of justice was thus not whether the share of profit taken by the ruling class was reasonable, but rather, "does this institution...provide me with a living regardless of what the land may yield this season?" (p.44). They therefore preferred their rent to be proportional to yearly production, rather than a fixed amount, as this eliminates the risk of a rent liability greater than available resources. Landlords were also pragmatic, postponing taxes in bad years. Colonial powers failed to appreciate the delicate balance of the moral order, imposing uniform and unyielding taxes that put people at risk of falling below the threshold. For Scott, this explained the unforeseen explosion of political violence in Vietnam and Burma in 1930-1931. Thus, the DTM may provide a useful vocabulary for work in comparative anthropology and political economy that examines moral orders, stability, and rebellion.

## 5.8 Conclusion

We have introduced the DTM, an idealised model of resource-dependent decision making that assumes individuals have a rock bottom in their utility functions, and a steep cliff around the point where they can satisfy their basic needs. The DTM makes predictions about what types of risk people will take, and when. It provides a principled understanding of why poverty, compared to affluence, would be associated both with more risk aversion, and more risk taking.

The DTM has potential to connect individual-level decision making to population-level and societal questions. These questions encompass the effects of increasing inequality on aggregate outcomes, and the behavioural effects and optimal design of the welfare state. For us, the DTM's potential role as a micro-macro linking theory is one of its main appeals, giving it the potential to lie at the heart of a generative research programme spanning cognitive and social sciences.

That said, the evidence for the DTM at the individual level needs to be strong for it to be considered credible. We do view the evidence we reviewed in section 5.3 as strong. It is particularly striking how diverse the contexts are, from subsistence communities to post-industrial ones, in which this mid-level idealisation has proved to be predictive and illuminating. However, like any mid-level theory of human behaviour, the DTM raises many further detailed questions about the interpretation of its key constructs, their cognitive representation, and how they apply to different societal contexts. We hope to have stimulated research on these issues by writing this article.