Understanding time-inconsistent heterogeneous preferences in economics and finance: a practice theory approach

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Abstract This paper introduces an innovative framework for decision making by individuals with inconsistent preferences. Practices, associations of individuals with a preference set shared by its members, provide context and unify preferences across an economy so that decision-makers are situated in social and economic structures. Our framework models the time evolution of certain attributes, emerging from the practice framework, that govern individuals' decisions and their intertemporal variation. A novel feature is that preferences are able to rank other preference sets without the need to aggregate them. Instead, the selection of a preference set is treated as a decision in its own right. Our framework explains decision making paradoxes such as the disposition effect and agency cost considerations that are frequently encountered in the behavioural finance and economics literature.

Keywords intertemporal choice · time-inconsistent preferences · multiple selves · disposition effect · decision theory

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1 Introduction

Time-inconsistent behaviour is a phenomenon well-documented in the fields of behavioural economics and finance. Since the seminal study of Thaler (1981), a significant volume of empirical work (Ainslie 1992; Harris and Laibson 2012; Laibson 1997; Lowenstein and Prelec 1992) shows that economic agents apply varying decision-making rules and act in a different manner depending on the timing of payoffs.[1] Efforts to explain such intertemporal behavioural traits utilise a wide range of modelling techniques with hyperbolic and quasi-hyperbolic discounting (Bleichrodt et al. 2009; Harvey 1989; Laibson 1997; Scholten and Read 2010) as well as monetary discounting rates (Noor 2009) amongst the most prevalent ones. Other approaches from the field of behavioural economics utilise cumulative prospect theory (Tversky and Kahneman, 1992) and explain time-inconsistent choices using alternative probability weighting components and shifts in the level of the reference point of prospect theory (Barseghyan et al. 2013; Hu and Scott 2007; Koszegi and Rabin 2009; Pagel 2013; Sydnor 2010). Economic agents therefore appear to exhibit heterogeneous preferences subject to a number of endogenous characteristics that are time-dependent at all stages of an individual's life.

Nonetheless, no prior studies have attempted to explore the varying role of individual social 'identity' and 'self-image' on inter-temporal behaviour with regards to economic decision-making. This paper fills this gap by introducing a novel approach for modelling heterogeneous preferences and time-inconsistent behaviour that merges two important strands of the literature: the work on economics of 'identity' (Akerlof and Kranton 2000, 2005)[2] and that on multiple self-models which argues that a decision maker is a collection of possibly different selves but acts in a context-dependent manner (Ambrus and Rozen 2015; Chatterjee and Krishna 2009; Cherepanov et al. 2013; Evren and Ok 2011; Green and Hojman 2007; Green and Hojman 2015; Manzini and Mariotti 2007). According to our framework, individuals are simultaneously members of sets of associations of people, that refer to as practices,[3] each with an activity and a shared system of values and beliefs. An individual's state of mind is, in part, a composition of the goods of the practices the individual belongs to. By extending Akelof and Kranton's (2000) argument, this form of belonging and especially the degree of the belonging determines (i) individual choices and (ii) choices at an aggregate level. However, alignment with one or another practice/association is

[1] Characteristic example of such a case is that of individual choices on pension's voluntary contributions where prior and current literature overwhelmingly suggests an intertemporal relationship between current and future consumption and investment.

[2] Akerlof and Kranton (2000) suggest that individuals directly obtain utility from their identity and the behaviour demanded by that sense of belonging. This behaviour requires inputs, and other group members can up to a point help enforce group behavioural input norms.

[3] The conceptual framework of virtues, goods and practices was introduced in the field of sociology and social interaction by Macintyre (1985).

time-inconsistent subject to the continuous change of individuals' mental frame as suggested by the prospect theory of Kahneman and Tversky (1979).

Hence, the contribution of this paper is twofold. First, unlike prior studies on intertemporal choice and heterogeneous preferences that are context-dependent, we model heterogeneous preferences across individuals using the notion of alternative but simultaneously-engaging 'practices' with the latter reflecting the wider spectrum of attributes that comprises an economic agent's 'identity'. This novel modelling framework is unique as it provides a context in which the complexity of individual decisions can be formalized and explored in a manner that integrates aspects of both classical utility theory and prospect theory, hence abridging these two theoretical propositions. As such, our model can best explain, with minimal assumptions on the underlying conditions, the seemingly irrational and inconsistent preferences of the sort frequently encountered in real-life decisions and which are extensively documented in the behavioural finance literature, for example disposition effect (Barberis and Xiong 2012; Odean 1998; Shefrin and Statman 1985; Weber and Camerer 1998), agency conflict (Dittmann and Maug 2007; Jensen 2005), and intertemporal decision-making (Dasgupta and Maskin 2005; Prelec 2004; Read and Read 2004; Sayman and Onculer 2009).

Second, unlike prior studies on multiple self-models that explore individual decision-making in isolation (Ambrus and Rozen 2015; Evren and Ok 2011; Manzini and Mariotti 2007), in our paper 'multiple selves' are economy-wide roles shared by, potentially, many individuals. We are therefore modelling individuals within an economy, rather than in isolation further extending the work of Ambrus and Rozen (2015). Since different individuals belong to different sets of practices, preferences are therefore heterogeneous across an economy. In our practice framework, aggregation is simply a projection on to a single practice good,[4] a process we refer to, as it involves a choice between goods, as an ethical decision. The existence of these ethical decisions is a distinguishing feature of the practice framework; they are context-dependent, endogenously defined, and they are formally modelled for the first time in the literature.[5]

The remainder of this paper is organized as follows. Section 2 presents the social and economic framework. Decision making is examined in section 3. Section 4 illustrates how our proposed 'practice-based' decision making framework can be used as a tool to explain the cases of the dis-

[4] Where 'good' denotes a shared value system and not a physical good.

[5] The use of an ethical rule for aggregation is fundamentally different to the numerous aggregation rules used in extant literature. For example, various studies address context-dependent preferences by modifying the modelling framework or a preference aggregation rule. Green and Hojman (2007, 2015) use a monotonic aggregation rule with ordinal preference rankings; Ambrus and Rozen (2015) use a best compromise aggregating rule; Manzini and Mariotti (2007) use a sequential procedure to eliminate suboptimal alternatives and Chatterjee and Krishna (2009) use a dual-self decision making model

position effect and the typical agency conflict during mergers and acquisitions; while section 5 discusses the results of our simulation. The paper concludes in section 6.

2 The modelling framework

We adopt the following premises:

1. Preferences are total orderings expressed via utilities.
2. Preferences rank not only states in an underlying state space but also rank other preferences.
3. It is possible to determine when underlying states and preferences are near to one another.
4. Preferences that give similar rankings in similar states are close to one another.

These premises are modelled by assuming that:

1. The underlying state space Ω is a Hilbert space over the reals, with its natural metric, and
2. Preferences are in $\mathcal{G} = L^2_k(\Omega)$, the weighted L^2 space on Ω with a suitable weight function $k : \Omega \to \mathbb{R}$ obeying $\int_\Omega k(u)\,du < 1$.

$\mathcal{G}$ is a Hilbert space and is canonically self-dual. With an appropriate choice of k the formulation includes cases where $g \in \mathcal{G}$ is linear or of classical utility form. In these circumstances a preference $g \in \mathcal{G}$ determines a ranking on $\mathcal{G}$ via the canonical isomorphism between $\mathcal{G}$ and $\mathcal{G}^*$ and closeness is measured by metrics induced by the Hilbert space structure. In more detail, the canonical isomorphism between $\mathcal{G}$ and $\mathcal{G}^*$ maps $g \in \mathcal{G}$ to $g^* \in \mathcal{G}^*$ where for all $h \in \mathcal{G}$, $g^*(h) = \langle g, h\rangle$. Then under the ranking $\leq_g$ induced by $g, g_1 \leq_g g_2$ if and only if $g^*(g_1) = \langle g, g_1\rangle \leq \langle g, g_2\rangle = g^*(g_2)$.

Say that $g, h \in \mathcal{G}$ are ε-close if for a given $\varepsilon > 0$ there exists $\delta > 0$ such that $|g(a) - h(b)| < \varepsilon$ whenever $|a - b| < \delta$. In particular if $g, h \in \mathcal{G}$ are ε-close then $|g(a) - h(a)| < \varepsilon$ for all $a \in \Omega$. Then in $\mathcal{G}$ we have $\|g - h\|^2 = \int_\Omega |g(u) - h(u)|^2 k(u)\,du < \varepsilon^2$, so g and h are within ε in $\mathcal{G}$. This substantiates premise 4. To be consistent with MacIntyre (1985), and with utilitarianism, where a "good" is a moral system that enables outcomes to be ranked, we refer to preferences in $\mathcal{G}$ as goods. For the moment we leave Ω indeterminate. We assume a population P of N individuals. Individuals engage in activities which cause states to follow trajectories in Ω. Write $\mathcal{A}$ for the space of activities. $\mathcal{A}$ is also modelled as a Hilbert space.

2.1 Practices, activities, and goods

The basis of our framework is the notion of a practice.[6]

[6] This is central to MacIntyre (1985), although his philosophical perspective contains no mathematical elements.

Definition 1 *A practice is a triple* $s = (S, a, g)$ *where* $S \subseteq P$, $a \in \mathcal{A}$, $g \in \mathcal{G}$.

Write $N_s = |S|$ for the number of individuals in s. S is the population of individuals in the practice.

Definition 2 *A practice structure over* P *is a set* $\Lambda = \{(S, a, g)\} \subseteq \mathcal{P} = P(P) \times \mathcal{A} \times \mathcal{G}$ *where* $P(P)$ *is the power set of* P.

A practice structure defines the activities and goods (preferences) in an economy. Examples of practices are firms, families, and social groups.[7] If $s \in \Lambda$ then s is of the form $s = (S_s, a_s, g_s)$ for $S_s \subseteq P$. The practice activity a_s is undertaken by individuals $p \in S$ in furtherance of the practice good g_s, that is, to reach states in Ω that are ranked higher under g_s. Write $\Lambda_S = \{s \in \Lambda \mid S_s = S\}$ for the set of practices based on $S \subseteq P$.

Definition 3 *For* $p \in P$, $\Lambda_p \equiv \Lambda_{\{p\}}$ *are* p*'s personal practices, the set of practices whose membership is precisely the individual* $p \in P$.

Definition 4 *For* $p \in P$, $\widehat{\Lambda}_p = \bigcup_{p \in S} \Lambda_S = \{s \in \Lambda \mid p \in S_s\}$ *is* p*'s participation practices - the set of practices that* p *belongs to.*

Λ_p represents p's personal activities and internal psychological states. We have $\widehat{\Lambda}_p = \Lambda_p \cup \Lambda_p^+$ where $\Lambda_p^+ = \left\{ s \in \widehat{\Lambda}_p \mid |S_s| \geq 2 \right\}$ is the set of practices containing p which has members other than p. Λ_p^+ constitutes p's social identities: groups of family and friends, membership of clubs and societies, work groups, *et cetera*.

Write $a_{s,p}$ for the activity undertaken by p in practice $s \in \widehat{\Lambda}_p$ so that $a_s = \sum_{p \in S_s} a_{s,p}$. p's total activity is $a_p = \sum_{s \in \widehat{\Lambda}_p} a_{s,p}$.[8]

It is easy to model various idealized paradigms.

[7] To that extent, practices represent facets of individuals' identity. Individual's roles in practices may not be distinct; they can overlap or even conflict with one another. This is not different to the main premises in multi-self modelling. As Ambrus and Rozen (2015 p.1139) point out "In an intrapersonal context,selves represent the DM's conflicting motivations or priorities."

[8] In reality p's activities cannot take place simultaneously. We interpret them as being split sequentially though time where, however, the time scales are small enough so that one may regard the activities as taking place simultaneously.

1. $\Lambda = \{(P, a, g)\}$. A society with a single common practice, to which every individual belongs. Society is homogenous.
2. $\Lambda = \{(P, a_1, g_1), \ldots, (P, a_n, g_n)\}$. A society with several common practices; every individual belongs to every practice. Individuals make decisions according to one of several different sets of preferences. Society is homogenous with multiple preferences.
3. $\Lambda = \left\{(P, a, g), \ \{(\{p\}, a_p, g_p)\}_{p \in P}\right\}$. A society with one common practice, to which every individual belongs, and a personal practice for every individual. Individuals have heterogeneous preferences, but nevertheless may also make decisions according to a shared set of preferences.
4. $\Lambda = \{(P_1, a_1, g_1), \ldots, (P_n, a_n, g_n)\}$ where $\bigcup_{i=1,\ldots,n} P_i = P$ and $P_i \cap P_j = \phi$, $i \neq j$. A society whose members are partitioned into a number of disjoint practices, each with a distinct set of preferences. This represents granular heterogeneous preferences which may, for instance, correspond to different attitudes to risk, different political or cultural allegiances, or different brand loyalties.
5. $\Lambda = \{(P, a_1, g_1), \ldots, (P, a_n, g_n)\}$ where $P = \{p\}$ has a single member. A society with a single representative individual who has multiple heterogeneous preferences.

The framework is flexible enough to model many different behavioural and societal patterns yet, as we illustrate in section 4, open to quantitative investigation.

2.2 States of mind

Fundamental to our framework is the idea that individuals have an internal state that we refer to as their state of mind. For each $s \in \widehat{\Lambda}_p$ there are three parameters contributing to p's state of mind: engagement, excellence, and salience.

Practice members have varying levels of commitment to the practices they belong to. A member $p \in S_s$ of a practice s has a level of engagement $\varepsilon_{p,s} \in [0, 1] \subset \mathbb{R}$ in s. $\varepsilon_{p,s}$ represents p's underlying degree of commitment to s. If $\varepsilon_{p,s} = 0$ for some practice s, $p \in S_s$, then p's commitment to s is purely nominal; if $\varepsilon_{p,s} = 1$ then p is fully engaged and committed to the practice. In a firm s, $\varepsilon_{p,s}$ captures p's motivation towards the firm. We suppose that every individual p has a maximum total engagement level, $\varepsilon_p^{\max}$, with $\sum_{s \in \widehat{\Lambda}_p} \varepsilon_{p,s} \leq \varepsilon_p^{\max}$, representing their capacity for social and intellectual interaction. Set $\varepsilon_p = \left\{\varepsilon_{p,s} \mid s \in \widehat{\Lambda}_p\right\}$.

Following MacIntyre (1985) we suppose that for every $s \in \widehat{\Lambda}_p$ there is an excellence $\chi_{p,s} \in [0, 1] \subset \mathbb{R}$. $\chi_{p,s}$ represents p's proficiency in pursuit of g_s, effectively the match between $a_{s,p}$ and g. Set $\chi_p = \left\{\chi_{p,s} \mid s \in \widehat{\Lambda}_p\right\}$.

Every $s \in \widehat{\Lambda}_p$ has a current immediate degree of salience with p, $m_{p,s} \in \mathbb{R}^+ \subset \mathbb{R}$. The set $m_p = \left\{ m_{p,s} \mid s \in \widehat{\Lambda}_p \right\}$ plays an important role in p's decision making process.

Definition 5 *The state of mind of $p \in P$ is the triple $M_p = \{\varepsilon_p, \chi_p, m_p\}$. The collective state of mind is $M = \{M_p \mid p \in P\}$.*

We treat ε_p as a decision variable under the control of p; m_p and χ_p evolve endogenously[9].

2.3 Economics and product dualism

We extend the notion of a practice to include explicit economic elements, so that individuals and practices become economic agents. We suppose that activities and goods are productive: activities generate 'benefit' and goods generate 'esteem'. Benefit represents a tangible, material, product. Esteem represents an intangible, immaterial, well-being felt by individuals through association with a good. Benefit is distributed by practices to other practices; esteem is acquired by members of a practice. To incorporate costs of production we allow activities to use up both benefit and esteem while being undertaken.

Benefit and esteem are not aggregated into a single measure. Instead they determine different categories of decision. The existence of two types of product, one external to the individual and the other internal, is natural. Individuals frequently make choices that are difficult to explain, or indeed are outside the universe of discourse, were they solely wealth maximizers. We are able to discriminant between outcomes whose differences are unsatisfactorily captured when only a single product exists.

Our notion of esteem to some extent quantifies the notion of 'warm glow' in decision making (Andreoni 1990; Evren and Minardi 2017; Lilley and Slonim 2014), and a concept similar to that of ego-utility found in the economic choice literature (Benabou and Tirole 2002; Koszegi 2006; Kuhnen and Tymula 2012).

Formally there exist maps $b : \mathcal{A} \longrightarrow \mathbb{R}$ and $e : \mathcal{G} \longrightarrow \mathbb{R}$ specifying the rates of production of benefit and esteem. Write $b_s(t) = b(a_s(t))$ and $e_s(t) = e(g_s(t))$ for the rates of production of benefit and esteem from a practice s at time t. b_s and e_s are negative for practices that are destroyers of benefit or negators of esteem. In this exposition there is no inter-temporal transfer in that the present value of expected future benefit received plays no role, although this could be incorporated.

[9] See section 2.5.

Let $c^b : \mathcal{A} \longrightarrow \mathbb{R}^+$ and $c^e : \mathcal{A} \longrightarrow \mathbb{R}^+$ be the rates that activities consume benefit and esteem, respectively. $c^b(a)$ is the benefit required to undertake the activity a regarded as a cost of production. Write $c^b_s(t) = c^b(a_s(t))$ and $c^e_s(t) = c^e(a_s(t))$ for the rates of consumption of benefit and esteem from a practice s at time t. For simplicity we suppose that b and e, c^b and c^e are linear.

Call a practice s with $b_s > c^b_s$ a productive practice; one with $b_s < c^b_s$ a consumptive practice. A firm is an example of a productive practice; a household of a consumptive practice.

2.3.1 Benefit distribution

Practices distribute benefit to other practices according to their good as part of their activity. Write $b_{s,s'}(t) \geq 0$ for the rate at which practice s distributes benefit to practice s'. We require that benefit flow is conserved in the sense that

$$b_s(t) + \sum_{s' \in \Lambda \setminus \{s\}} b_{s',s}(t) = c^b_s(t) + \sum_{s' \in \Lambda} b_{s,s'}(t). \tag{1}$$

We do not require that that $b_{s,s} \equiv 0$. If $b_{s,s} \neq 0$ then s is either adding to or subtracting from a store of benefit. If s is a firm then $b_{s,s}$ models retained earnings. It is possible to model a banking sector by allowing certain practices to behave as lenders of benefit.

We assume that an activity may be undertaken only if

$$\sum_{s' \in \Lambda} b_{s',s}(t) \geq c^b_s(t), \tag{2}$$

that is, s must be able to support its activity's cost of production from the income it is receiving, including retained earnings, irrespective of the benefit being produced.

The activity of a practice may be distributed among sub-practices.

Definition 6 *A contributing sub-practice s' of a practice s, with $b_s \neq 0$, is a practice such that $S_{s'} \subseteq S_s$ and*

1. *if s is a productive practice then $b_{s',s} > 0$ and $b_{s',s} = b_{s'} - c^b_{s'}$.*
2. *if s is a consumptive practice then $b_{s,s'} > 0$ and $b_{s,s'} = c^b_{s'} - b_{s'}$.*

A production contributing sub-practice passes on all the net benefit it produces to s; a consumption sub-practice receives all its net consumption from s. Write Λ_s for the contributing sub-practices of s. The effective production of s is $b'_s = \sum_{s' \in \Lambda_s} b_{s'}$. The effective activity is $a'_s = \sum_{s' \in \Lambda_s} \sum_{p \in S_{s'}} a_{s'}$.

For each practice $s \in \widehat{\Lambda}_p$ there may exist a special personal practice contributing to s, the role practice $\langle s \rangle_p \in \Lambda_p \cap \Lambda_s$. Its good $g_{\langle s \rangle_p}$ is p's conception of g_s. Role practices for $s \in \Lambda_p$ relate to internal psychological states. If p is clear from context we will drop the p subscript.

We suppose that individuals receive benefit through their personal practices. For instance when s is a firm practice the benefit is received by $\langle s \rangle_p$ in the form of p's salary or wages, along with any additional perks that p receives from s as a consequence of p's role in the firm.

The total benefit rate $b_p(t)$ received by p is the sum of the benefit received by p's personal practices

$$b_p(t) = \sum_{s' \in \Lambda_p} \sum_{s \in \Lambda \setminus \Lambda_p} b_{s,s'}(t). \tag{3}$$

We suppose that there is a distinguished personal practice, $[p] \in \Lambda_p$, the personal economic practice of p, whose activity is the distribution of net benefit received by p and whose good $g_{[p]}$ captures the value to p of benefit received. Formally we suppose that all benefit received by each $\langle s \rangle_p$ is passed over to $[p]$. Decisions made under $g_{[p]}$ could be classical wealth maximization decisions in which benefit plays the role of wealth but more general criteria are possible. For instance the simulation example of section 4 has a $g_{[p]}$ that favours savings to spend. Other choices could indeed maximize net income received, or emphasize particular categories of spend.

2.3.2 Esteem

We suppose that individuals p receive esteem from $s \in \widehat{\Lambda}_p$ in proportion to their engagement, and lose esteem through involvement in practice activity, also in proportion to their engagement. Esteem is also lost from interaction with other practices, and is diluted according to the number of people in s. Increased excellence increases the esteem gained and decreases the esteem lost. We set the net rate of esteem $e_p(t)$ received by p to be

$$e_p(t) = \sum_{s \in \widehat{\Lambda}_p} \varepsilon_{p,s}(t)\, v_{p,s}(t), \tag{4}$$

$$v_{p,s}(t) = \frac{1}{N_s}\left(\chi_{p,s}(t)\, n_{p,s}(t) - k_p\left(1 - \chi_{p,s}(t)\right) u_{p,s}(t)\right) \tag{5}$$

where $n_{p,s}(t) = e_s(t) - c_s^e(t)$ is the net esteem generated by s, $u_{p,s}(t)$ is esteem lost from practice interaction with s (see section 2.4), and k_p is a weighting factor. Esteem, unlike benefit, is not redistributed and is not conserved.

Analogous with $[p]$ we suppose that there is a distinguished personal practice, $\{p\} \in \Lambda_p$, the personal well-being practice of p, that receives the esteem received by p and whose good $g_{\{p\}}$ captures the value to p of the well-being p experiences. Individuals can act so as to optimize under

$g_{\{p\}}$. Decisions made under $g_{\{p\}}$ determine practice membership and engagements. Intuitively these correspond to life-style choices. The ability to combine in a single framework life-style decisions with other types of decisions is a contribution of the practice framework. Note that the esteem received from $[p]$ contributes to $g_{\{p\}}$, and that $\{p\}$ receives esteem from p's membership of $\{p\}$ itself, so that self-esteem can contribute to p's lifestyle choices.

2.4 Practice dynamics

Practices influence one another causing their goods and activities to evolve through time. We assume

1. Every practice s has a 'pure' good $\widehat{g}_s$, with $\|\widehat{g}_s\| = 1$, fixed through time, defining the character of the practice. We suppose that $\{\widehat{g}_s\}_{s\in\Lambda}$ are pairwise orthogonal and that $e(\widehat{g}_s) = 1$.
2. Corresponding to every $\widehat{g}_s$ is an activity $\widehat{a}_s$, $\|\widehat{a}_s\| = 1$, optimal for $\widehat{g}_s$. We suppose that $\{\widehat{a}_s\}_{s\in\Lambda}$ are pairwise orthogonal, $b(\widehat{a}_s) = 1$, and that the map $\iota : \widehat{g}_s \longmapsto \widehat{a}_s$ is an injection.
3. Each g_s has a predisposition to revert towards $\mu^{g,s} = \|g_s\|\,\widehat{g}_s$, and each a_s a predisposition to revert towards $\mu^{a,s} = \|a_s\|\,\widehat{a}_s$. The strength of reversion is proportional to the separation from the reversion state.
4. The influence that a practice s has on a target practice s' is to cause s' to become more like s, and hence ranked more highly under g_s[10]
5. The influence that a practice s has on the good (activity) of s' is proportional to the congruity of the goods (activities) of the two practices, relative to the pure good of the influencing practice.

Hence we set

$$\frac{dg_s}{dt} = \alpha^g \|\mu^{g,s} - g_s\|\,(\mu^{g,s} - g_s) + \alpha^g \sum_{s'\in\Lambda\setminus s} \kappa^g_{s,s'}\,(g_{s'} - g_s)\,, \tag{6}$$

$$\frac{da_s}{dt} = \alpha^a \|\mu^{a,s} - a_s\|\,(\mu^{a,s} - a_s) + \alpha^a \sum_{s'\in\Lambda\setminus s} \kappa^a_{s,s'}\,(a_{s'} - a_s) \tag{7}$$

for $\alpha^a, \alpha^g > 0$, subject to $\sum_{s'\in\Lambda} b_{s',s} \geq c^b(a_s)$.

$\kappa^g_{s,s'}$ and $\kappa^a_{s,s'}$ are the strengths of influence s' has on s. For concreteness we suppose that $\kappa^g_{s,s'} = \kappa^a_{s,s'} \equiv \kappa_{s,s'}$ with

$$\kappa_{s,s'}(t) = |u(s,s')|\,(W(a_s) + L(g_s)) \tag{8}$$

[10] Implementing the so-called isomorphism principle (Di Maggio and Powell 1983).

This form of $\kappa_{s,s'}$ arises from the stakeholder literature (Mitchell et al. 1997). $u(s,s')$ is interpreted as a measure of the urgency of the interaction between s and s', and $W(s)$ and $L(s)$ represent the power and legitimacy of s.

We interpret $\kappa_{s,s'}$ as pressure felt both by the practice and by members of the practice. We set the total pressure $u_{p,s}(t)$ felt by $p \in P$ through membership of s to be

$$u_{p,s}(t) = \frac{1}{N_s} \sum_{s' \in \Lambda \setminus \Lambda_p} \kappa^a_{s',s} \tag{9}$$

so that pressure is distributed across the members of s. We identify the $u_{p,s}(t)$ terms in equations 5 and 9: p loses esteem through pressure felt by p from practices that interact with s.

2.5 Mental state dynamics

An individual p's mental state M_p evolves through time. In this section we model the evolution of χ_p and m_p.

2.5.1 Excellence

We suppose that excellence increases through time in proportion to engagement, but improvement becomes progressively more difficult. To model this we make $\chi_{p,s}(t)$ a function of $\varepsilon_{p,s}(t)$ via $b_{p,s}(t)$,

$$b_{p,s}(t) = \alpha_b b_p(a_s(t)) \int_0^t \varepsilon_{p,s}(\tau)\, d\tau \ , \tag{10}$$

for some $\alpha_b > 0$ and $b_p \in \mathcal{A}^*$, constants, and assume that

$$\frac{d\chi_{p,s}(b_{p,s})}{db} = 1 - \chi_{p,s}(b_{p,s}) \ , \tag{11}$$

so that $\chi_{p,s}$ never exceeds 1. Then

$$\chi_{p,s}(t) = 1 - (1 - \chi_{p,s}(0)) \exp\left(-\alpha_b \langle b_p, a_s(t)\rangle \int_0^t \varepsilon_{p,s}(\tau)\, d\tau\right). \tag{12}$$

for an initial excellence $\chi_{p,s}(0)$.

2.5.2 Salience

Write $\mathcal{M}_p = \{m_p\} = \prod_{s \in \widehat{\Lambda}_p} \mathbb{R}^+$ for the space of possible saliences of p. There is a map $\iota : \mathcal{M}_p \to \mathcal{G}$, $m_p \mapsto \sum_{s \in \widehat{\Lambda}_p} m_{p,s} g_s$. Write $\mathcal{G}_p$ for the image of $\mathcal{M}_p$ in $\mathcal{G}$. $\mathcal{G}_p$ represents the set of goods accessible to p. We identify m_p with $\widehat{m}_p = \iota(m_p) \in \mathcal{G}_p$.

$\widehat{m}_p$ evolves through time. We suppose that $\widehat{m}_p$ experiences an attraction towards each g_s, $s \in \widehat{\Lambda}_p$, according to the importance of s to p. Importance to p is measured by the esteem that p receives from s so we write

$$\frac{d\widehat{m}_p}{dt} = \alpha_m \sum_{s \in \widehat{\Lambda}_p} \varepsilon_{p,s} v_{p,s} \left(g_s - \widehat{m}_p\right) \tag{13}$$

for a reversion rate $\alpha_m > 0$, where $v_{p,s}$ is given by equation 5.

3 Decisions

A 'physical' state ω is

$$\omega = \left\{ \{a_s\}_{s \in \Lambda}, \quad \{b_{s,s'}\}_{s,s' \in \Lambda}, \quad \{M_p\}_{p \in P} \right\} \tag{14}$$

This contains neither practice goods nor esteem. Write $\Omega = \mathcal{A}^{|\Lambda|} \times \mathbb{R}^{|\Lambda| \times |\Lambda|} \times (\mathbb{R} \times \mathbb{R})^{|P|}$ for the space of ω. Activities act on Ω to change $\{a_s\}_{s \in \Lambda}$ according to equation 7. A natural Hilbert bracket on Ω is defined pointwise on the components of states $\omega \in \Omega$ (although in general cross terms could be present between the different components of Ω).

Suppose that $g \in \mathcal{G}$ has the form

$$g(\omega) = \sum_{s \in \Lambda} g^s(a_s) + \sum_{s,s' \in \Lambda} g^{s,s'}(b_{s,s'}) + \sum_{p \in P} \left(g^{p,\varepsilon}(\varepsilon_{p,s}) + g^{p,m}(m_{p,s})\right) \tag{15}$$

for components g^s, $g^{s,s'}$, $g^{p,\varepsilon}$, and $g^{p,m}$ of g. The first term weights activities, the second the distribution of benefit, and the third individuals' attitudes. If g is the good of a firm practice s the second term might be of the form

$$\sum_{s,s' \in \Lambda} g^{s,s'}(b_{s,s'}) = k_b \sum_{s' \in \Lambda} \left(b_{s',s} - b_{s,s'}\right), \tag{16}$$

for some constant $k_b > 0$, so that g maximizes net benefit income to the firm.

The effective state space $\overline{\Omega}$ is

$$\overline{\Omega} = \Omega \times \prod_{s \in \Lambda} \mathcal{G}_s, \tag{17}$$

where $\mathcal{G}_s$ are isomorphic copies of $\mathcal{G}$, so that the good of each practice is part of states in $\overline{\Omega}$. Goods $g \in \Omega$ lift to goods $\overline{g} \in L^2_k\left(\overline{\Omega}\right)$:

$$\overline{g}\left(\omega, \{g_s\}_{s \in \Lambda}\right) = g(\omega) + \sum_{s \in \Lambda} g(g_s) \tag{18}$$

Decisions are made by practices and by individuals *qua* individuals. A practice decision selects from a set of attainable future states (effected by choosing an appropriate activity) in order to optimize according to its practice good.

Individual decision making takes two forms, ethical and lifestyle. We suppose that when an individual $p \in P$ makes a decision they do so according to the good of one of their participation practices. There is thus a requirement for a prior decision that determines the choice of practice good used to make the underlying decision. We call this prior decision an ethical decision. It is a form of aggregation by projection.

The second form of individual decision concerns the determination of the engagements ε_p. This is a practice decision made under $g_{\{p\}}$. As it determines the emphasis p places on the different aspects of their life we call these lifestyle decisions. The three types of decision - practice, ethical and lifestyle - are categorically distinct. We discuss each decision type in turn.

3.1 Practice based decision

A practice based decision is a decision made in accordance with a practice's good. Formally, a practice based decision (under certainty)[11] is a triplet $\Delta^P = \{s, D, c\}$ where $s \in \Lambda$ is the practice making the decision, $D = \{d_q\}_{q \in Q} \subset \Omega$ is a set of possible outcomes, and $c : \{*\} \longrightarrow D$ is a function recording the outcome $c^* \in D$ of the decision. Outcomes $d_q \in D$ are ranked according to g_s, the good of s. Given the current state $\omega_0 \in \Omega$ each $d \in D$ must be feasible, that is, be an outcome reachable from ω_0 using activities available to s.

A very great deal of the decision making literature focuses on, in our terminology, practice based decisions, that is, decisions where a criterion is given, perhaps with aggregation, and the issue is to determine an optimal choice under this criterion (Nehring 2009; Gilboa et al. 2010; Cres et al. 2011; Danan et al. 2014; Qu 2017; Agastya and Slinko, 2015).

3.2 Lifestyle decisions

Lifestyle decisions are made by individuals who choose ε_p under $g_{\{p\}}$. As an illustration suppose that under $g_{\{p\}}$ p maximizes $e_p = \sum_{s \in \widehat{\Lambda}_p} \varepsilon_{p,s} v_{p,s}$ where $v_{p,s}$ is given by equation 5. Write $\widehat{\Lambda}_p = \{s_i\}_{i \in I}$, for some index set I. Rank practices s_i in $\widehat{\Lambda}_p$ so that $i < j$ if and only if $v_{p,s_i} > v_{p,s_j}$, so that s_1 has the greatest rate of net esteem generation, s_2 the second greatest, *et cetera*. Let

[11] Practice decisions may be extended to uncertainty using ordinary expected utility arguments.

$i^* = \left\lfloor \varepsilon_p^{\max} \right\rfloor$ and set

$$\varepsilon_{p,s_i}(t) = \begin{cases} 1, & \text{if } i \leq i^*, \\ \left\lfloor \varepsilon_p^{\max} \right\rfloor - i^*, & \text{if } i = i^*, \\ 0, & \text{if } i > i^*. \end{cases} \tag{19}$$

This determines a bang-bang engagement policy, essentially either total engagement or none at all, optimal under this $g_{\{p\}}$. It is unrealistic, reflecting the unrealistic nature of the illustrative $g_{\{p\}}$. In practice individuals have complex criteria and may, for instance, be constrained to maintain a minimum level of engagement even in practices with low, or negative, values of e_s. In such cases levels of engagement with values in the interior of $[0, 1]$ could be found.

In this example lifestyle decisions are effectively endogenized. Engagement levels change only when $v_{p,s}$ change sufficiently to change the practice rankings. When $v_{p,s}$ are fixed no lifestyle decisions are possible.

3.3 Ethical decisions

An ethical decision (under certainty) is a triplet $\Delta^E = \{p, D, \hat{c}\}$ where $p \in P$ is the individual making the decision, $D = \{d_q\}_{q \in Q} \subset \Omega$ is a set of possible outcomes as before, and $\hat{c} : \{*\} \longrightarrow \widehat{\Lambda}_p$ records the outcome of the decision. In this case $\hat{c}^* \in \widehat{\Lambda}_p$ is the practice chosen to take the underlying practice based decision, $\Delta^P = \{\hat{c}^*, D, c_{\Delta^E}\}$. Ethical decisions are made immediately preceding an underlying practice based decision. Their choice is not the direct determination of c^* but the choice of a mediating good g_s for some $s \in \widehat{\Lambda}_p$. g_s then makes the underlying decision. Ethical decisions made by $p \in P$ are contingent on the saliences m_p.

We suppose that the ethical decision making process has three steps by which individuals in our framework, implicitly or explicitly, make decisions. The steps are:

1. Establish the significant factors in the decision. This locates the decision D in the cone $\mathcal{G}_p$.
2. Assess the importance to the decision maker p of each factor. This computes a mutual salience weighting between D and $\widehat{m}_p$ for each good g_s.
3. Select a mediating good based on the relative importance to the decision maker of each factor.

We elaborate on each step.

Establish the location of the decision D in the cone $\mathcal{G}_p$

We find weights $\{v_s\}_{s \in \Lambda_p}$, $v_s \geq 0$, that locate D in $\mathcal{G}_p$,

$$D \longmapsto D' = \sum_{s \in \widehat{\Lambda}_p} v_s g_s. \tag{20}$$

A weight v_s represents the significance of the decision to the corresponding factor, g_s, to p. Suppose $D = \{\omega_q\}_{q\in Q} \subset \Omega$. For g_s, $s \in \widehat{\Lambda}_p$, outcomes have values $\left\{u_q^s\right\}_{q\in Q}$, $u_q^s = g_s(\omega_q)$. If $\left\{u_q^s\right\}_{q\in Q}$ have similar values then g_s will be relatively indifferent to the outcome. If there is a wide range of values $\left\{u_q^s\right\}_{q\in Q}$ the g_s will be much more affected by the outcome. So the salience of D to g_s is reflected the spread of values achieved among the outcomes $\{\omega_q\}_{q\in Q}$. A natural measure of the dispersion of $\left\{u_q^s\right\}_{q\in Q}$, also used by Ambrus and Rozen (2015) and Tversky (1969), is the spread between the maximum and minimum values. Hence we set

$$v_s = \max\left\{u_q^s\right\}_{q\in Q} - \min\left\{u_q^s\right\}_{q\in Q}. \tag{21}$$

Assess the personal importance for p of D to each factor g_s

The importance $\lambda_{p,s}$ to p of D in each factor g_s depends upon p's mental state. We suppose that $\lambda_{p,s}$ reflects the degree of communality between D' and $\widehat{m}_p$ in the direction g_s. A natural measure of communality is the product of the lengths of the orthogonal projections of D' and $\widehat{m}_p$ onto g_s. Write $\pi_{g_s}(g) = g_s \frac{\langle g, g_s\rangle}{\langle g_s, g_s\rangle}$ for the orthogonal projection of g onto g_s and set

$$\lambda_{p,s} = \langle \pi_{g_s}(D'), \pi_{g_s}(\widehat{m}_p)\rangle = |\langle D', \widehat{m}_p\rangle| \frac{\cos(\theta_{D',g_s})\cos\left(\theta_{\widehat{m}_p,g_s}\right)}{\cos\left(\theta_{D',\widehat{m}_p}\right)}$$

then set $\lambda_p = \sum_{s\in\widehat{\Lambda}_p} \lambda_{p,s}$.

If the set $\{g_s\}$ were pair-wise orthogonal then $\lambda_{p,s}$ reduces to

$$\lambda_{p,s} = \frac{\langle D', g_s\rangle\langle \widehat{m}_p, g_s\rangle}{\|g_s\|^2} = v_s w_s \|g_s\|^2, \tag{22}$$

just a scaled inner product.

Select the mediating good according to the degrees of importance

To be consistent with observed empirical inconsistencies in decision making we want to make the choice of mediating good probabilistic. Select the mediating good g^* randomly from the set $\left\{g_s \mid s \in \widehat{\Lambda}_p\right\}$ where g_s is selected with probability

$$\tau_s = \lambda_{p,s}/\lambda_p = \frac{\cos(\theta_{D',g_s})\cos\left(\theta_{\widehat{m}_p,g_s}\right)}{\sum_{s'\in\widehat{\Lambda}_p}\cos\left(\theta_{D',g_{s'}}\right)\cos\left(\theta_{\widehat{m}_p,g_{s'}}\right)}. \tag{23}$$

Now set $c^* = c^*_{g^*}$ with $c^*_{g^*}$ determined by $\geq_{g^*}$. Note that were the set $\{g_s\}$ pair-wise orthogonal then

$$\lambda_p = \sum_{s'\in\widehat{\Lambda}_p} \langle D', g_s\rangle\langle \widehat{m}_p, g_s\rangle = \sum_{s'\in\widehat{\Lambda}_p} v_s w_s \|g_s\|^2 = \langle D', \widehat{m}_p\rangle \tag{24}$$

hence

$$\tau_s = \lambda_{p,s}/\lambda_p = \frac{1}{\|g_s\|^2}\frac{\langle D', g_s\rangle\langle \widehat{m}_p, g_s\rangle}{\langle D', \widehat{m}_p\rangle}. \tag{25}$$

Faced with two decisions, one straight after another, individuals are more likely to use the same criterion for the second decision as they did for the first. This is captured by our formulation. Since the probability of selecting g_s is increasing in $m_{p,s}$, the greater $m_{p,s}$ the greater the likelihood of g_s being selected each time the decision is made.

For two distinct individuals p_1 and p_2 we may have $\mathcal{G}_{p_1} \neq \mathcal{G}_{p_2}$. This implies that during the first step, locating D in $\mathcal{G}_p$, every individual will assess D differently. p is more highly engaged in practices where they gain greatest esteem. These practices have greatest salience, so there is a link between ethical choice and lifestyle choice. When the outcome $d \in D$ is uncertain, so that d is a random variable taking values in a set $\{d_r\}_{r\in R}$, we suppose that individuals establish sets of subjective probabilities and base their judgements upon these. For an individual p and a good g, where $g = g_s$ for some $s \in \widehat{\Lambda}_p$, a set of subjective probabilities $\{v_r^{g,p}\}_{r\in R}$ is determined for p by g. The ranking of d under the good g might then be computed from an expected value under g of the possible outcomes d_r with the subjective probabilities $v_r^{g,p}$,

$$g(d) = \sum_{r\in R} v_r^{g,p} g(d_r). \tag{26}$$

4 The agency problem and the disposition effect

In this section we show how the practice framework can provide a context in which to discuss agency problems, in particular a mergers and acquisitions (M&As) situations, and the disposition effect.

4.1 An agency problem: mergers and acquisitions

Empirically managers are seldom driven by incentives, such as executing stock options, when deciding on potential acquisitions (Dittmann and Maug 2007; Harford and Li 2007), especially when their own stock appears to be overvalued (Jensen 2005). Rather their own personal objectives (Cho et al. 2016; Roll 1986) determine their decisions. In the practice framework this agency problem can be expressed as managers making decisions, in this case an M&A decision, under a good other than the shareholder good.

A simplified practice structure is shown in Figure 1. The right hand side of the figure represents a standard agency view. The left hand side represents some additional practices relevant in the

practice framework. In the standard model, in our terminology, the shareholder practice S influences the director practice D controlling the firm practice F, to align g_D and g_F with g_S. It does this not only by applying direct pressure on D but also by setting up a remuneration structure so that (in practice terms), for a director p, p's economic practice $[p]$ influences $\langle D \rangle_p$ so that p's decisions are aligned with g_S. Even supposing that $g_S = g_D = g_{\langle D \rangle_p} = g_F$, so that in principle, in the standard model, the shareholders have achieved their objective, it is clear under the extended model in the practice framework that this conceptualization is fundamentally flawed. Firstly, $[p]$ may receive benefit not only as a director but only as a consequence of p's membership and control of F. Benefit transfer from $\langle F \rangle_p$ to $[p]$ in the form of perks may be significant. If it is then the influence of $[p]$ on $\langle D \rangle_p$ may no longer favour g_S. One supposes that with appropriate oversight shareholders could overcome this problem.

[Insert Figure 1 about here]

Secondly, when p makes a decision they may not do so under $g_{\langle D \rangle_p}$ or $g_{[p]}$; instead, an ethical decision may select $g_{\langle F \rangle_p}$ or $g_{\{p\}}$ as the mediating practice. p receives not only benefit but also esteem, and esteem is received not only from $[p]$ but also from F and $\langle F \rangle_p$. If p is heavily engaged with F then more esteem is received from F. Decisions taken under $\{p\}$ are not necessarily aligned to g_S and may favour F over S. This esteem problem is potentially severe. Managers who receive most of their esteem from $[p]$ are less affected by it, but in practice humans are rarely motivated solely by financial gain. The esteem received from F and $\langle F \rangle_p$ could be determined by a variety of factors other than the alignment of g_F with g_S. In an M&A situation these could include size and prestige factors. p could gain esteem merely from M&A activity itself.

The practice framework not only provides a context for the agency problem, it also suggests potential solutions. Overcoming the esteem problem would appear to involve either decreasing the esteem received from F and $\langle F \rangle_p$ or increasing the esteem received from D, $\langle D \rangle_p$, and $[p]$. Increasing the esteem received from $[p]$ might be achievable by a careful design of p's remuneration package but successfully implementing this strategy, particularly with a manager more esteem oriented than financially oriented, could potentially be expensive. Increasing the esteem received from membership of D might be feasible, and almost certainly cheaper. Aligning $g_{\{p\}}$ with g_S, so that p derives esteem from, effectively, identifying with shareholders, seems problematic. In general a shareholder $q \in S$ would not derive their esteem primarily from their membership of S; it seems unreasonable that $p \in D$ should be expected to hold g_S more important than some other $q \in S$ does. The root of the problem is the assumption that S is, or adopts a position of being, driven solely by wealth maximization. Even if through stock options, or through direct stock holdings,

$p \in S$, so that p's wealth were correlated with benefit received by S, p's esteem, like q's, would not derive solely from S.

4.2 Practice theory and the disposition effect

One of the most robust behavioural traits of stock market investors is the so-called disposition effect (Barberis and Xiong 2009; Odean 1998). This is the tendency for investors to sell profitable investments relatively quickly but to hold on to loss making investments. Prospect theory explains this behavioural characteristic by supposing that investors have a value function, $v^p(w - w_0)$, a function of wealth relative to a reference level w_0, of the form shown in Figure 2, panel A. w_0 can be taken to be the initial value of the investment. This acts like a utility function so that losses are weighted proportionately less than gains; investors would therefore be less inclined to sell losers. Practice theory offers an alternative explanation. This is more natural in that it preserves the classical form of utility function.

We suppose that the decision of whether or not an investor p closes out a position is made by one of two practices: p's economic practice, $[p]$, and p's economic role practice, $\langle [p] \rangle$. The good of $\langle [p] \rangle$ is p's assessment of their economic proficiency. The state of the system is a pair $(\Delta w, \Delta s)$ where $\Delta w = w - w_0$ is the change in the value of p's cash holding and $\Delta s = s - w_0$ is the change in the value of the investment asset owned by p.

[Insert Figure 2 about here]

If p behaves as a representative economic agent then they are indifferent between holding the asset and selling it at its market rate, hence we assume that $g_{[p]}(\Delta w, \Delta s) \equiv g_{[p]}(\Delta w + \Delta s)$. However the good $g_{\langle [p] \rangle}$ measures changes in investment value differently to changes in cash value, $g_{\langle [p] \rangle}(\Delta w, \Delta s) = g^w_{\langle [p] \rangle}(\Delta w) + g^s_{\langle [p] \rangle}(\Delta s)$, say. As, relative to w_0, p holds either cash or the asset, but not both simultaneously, we can write $g_{\langle [p] \rangle}(\Delta w, \Delta s) = g_{\langle [p] \rangle}(\Delta s)$ up until the moment the asset is sold, and $g_{\langle [p] \rangle}(\Delta w, \Delta s) = g_{[p]}(\Delta w)$ after the asset is sold. Suppose the goods $g_{\langle [p] \rangle}$ and $g_{[p]}$, as functions of $w_0 + \Delta w + \Delta s$, have the forms illustrated in Figure 2, panel B. Each is of classical form. $g_{[p]}(w)$ is positive if the investment is successful, $w > w_0$; it has positive slope and is concave. It is natural that $g_{\langle [p] \rangle}(0) > 0$; p has had the confidence to make the investment so there is positive value under $\langle [p] \rangle$ in having made it. Note that $g_{\langle [p] \rangle}$ is shown with greater concavity than $g_{[p]}$.

An ethical decision decides which of the two practices is the mediating practice The likelihoods of selecting $[p]$ or $\langle [p] \rangle$ are determined by $v_{[p]}$ and $v_{\langle [p] \rangle}$ in equation 21. With our assumptions $v_{[p]} \equiv 0$ but $v_{\langle [p] \rangle} = g_{\langle [p] \rangle}(\Delta s) - g_{[p]}(\Delta s)$. All other things being equal, $\langle [p] \rangle$ is more likely to be

chosen than $[p]$ when $w_d < \Delta s < w_u$ and less likely outside this interval. Since $g_{\langle [p] \rangle}(\Delta w, \Delta s) \geq g_{[p]}(\Delta w, \Delta s)$, p is is less likely to sell under $\langle [p] \rangle$. Hence p will exhibit the disposition effect. Note that for $\Delta s \ll 0$ p behaves as if governed by $[p]$ and will sell.

Pure prospect theory would correspond to Figure 2, panel C, in which $w_u = w_0$. A situation in which p rapidly closes out losers while running with winners is shown in panel D in which $w_u - w_0 > w_0 - w_d$. Practice theory provides an elegant explanation of this aspect of investor behaviour and, by modifying the forms of $g_{[p]}(w)$ and $g_{\langle [p] \rangle}(w)$, is capable of expressing a wider range of behaviour than our prospect theory. For instance, $g_{[p]}(w)$ could have greater concavity than $g_{\langle [p] \rangle}(w)$,or $g_{[p]}(w)$ and $g_{\langle [p] \rangle}(w)$ could intersect only once, or not at all. Although it seems reasonable that $g_{\langle [p] \rangle}(w_0) > 0 = g_{[p]}(w_0)$, this might not hold in general.

5 Simulation illustration

A CEO, p, choosing how to allocate surplus cash resources makes different decisions depending on which good she chooses, consciously or not, to make the decision with. The goods of each of p's participation practices are likely to make different choices. Made by the firm good, p might choose to allocate most resources to benefit key corporate stakeholders such as shareholders, the workforce, or customers. Her social good might incline p to use resources in activities designed to enhance her social status such as using the firm's resources for corporate expansion or empire-building. Finally p's economic good might choose an outcome that maximizes her personal wealth or consumption. An ethical decision determines which participation practice makes the allocation decision.

Figure 3 shows a simplified practice network for an individual p. The practice structure is $\Lambda = \{H,\ S,\ F, \langle H \rangle_p,\ \langle S \rangle_p,\ \langle S \rangle_p,\ [p],\ \mathcal{E}\}$ for a household practice H, a social practice S, a firm practice F, role practices $\langle H \rangle$, $\langle S \rangle$, and $\langle F \rangle$, and p's economic practice $[p]$. We now drop the p subscript on the role practices. The practice $\mathcal{E}$ represents the external world, $p \notin \mathcal{E}$. Values attached to arrows represent rates of benefit transfer, comprising cash and product. Circular arrows from a practice to itself represent savings. In the simulation p contributes to H and S. $\langle F \rangle$ is a contributing productive practice to the firm F. It generates benefit of 1 (as labour) which is transferred to the firm in return for (a salary of) 0.9. Salary is distributed via $[p]$, $\langle H \rangle$ and $\langle S \rangle$ to H and S. $\langle H \rangle$ is a contributing consumptive practice to the household H. Household activity consumes 0.4, $c^b_H = 0.4$, and $c^b_{\langle H \rangle} = 0.1$ supported by a transfer of 0.1 from H; we have $c^b_S = 0.3$, funded by income from H and $\langle S \rangle_p$; $[p]$ has $b_{[p],[p]} = 0.1$ denoting savings at this rate.

[Insert Figure 3 about here]

Only net flows to and from $\mathcal{E}$ are shown. The simulation assumes that total labour of 1000, and additional product generation by F itself of $b_F = 50$, is converted into product all of which is sold. Of this H buys 0.6 and S buys 0.3. Flows to $\mathcal{E}$ from F are 899.1 of wages plus 1049.1 of product; Flows to F from $\mathcal{E}$ are 999 or labour plus 1048.1 of product purchased. Salary expenses total 900 so there is a residue $b_{F,F} = 150$ of retained earnings. We suppose the spaces of activities and goods are each seven dimensional. $\{\widehat{g}_s\}_{s\in\Lambda}$ and $\{\widehat{a}_s\}_{s\in\Lambda}$ form a basis for $\mathcal{G}$ and $\mathcal{A}$ respectively. Each practice is in its pure state for both its activity and its good, $g_s = \widehat{g}_s$, $a_s = \widehat{a}_s$, for all $s \in \Lambda$. We assume for simplicity that g_s and a_s are constant. Effectively in equations 6 and 7 we set $\alpha^g = \alpha^a = 0$.

Table 1 gives the rates of production of benefit and esteem associated with each pure activity and good and the costs of each pure activity. These are consistent with Figure 3. Table 1 also gives practice sizes, N_s, and minimum required levels of engagement for each practice, $\varepsilon_{\min,s} = 0.1$. We impose a maximum level of engagement for this individual, $\varepsilon_p^{\max} = 3$. A consequence of this specification is that at any one time two practices have engagement 1, one practice has engagement 0.6, and the remaining four practices have minimum engagement 0.1. The final columns give initial values of the saliences $m_{p,s}$ and excellences $\chi_{p,s}$, and specifies the vector b_p used in equation 10. Initially every practice has equal salience with p.

[Insert Table 1 about here]

Rates of benefit transfer are given in Table 2; they are consistent with the transfer rates shown in Figure 3. Table 3 shows urgencies, powers and legitimacies, while the goods $\widehat{g}_s$ are specified in Table 4 by their effect on basis elements of Ω, assumed to be linear. Entries in the table receive a weight of either $+1$ or -1, as indicated, from the corresponding good. All other weights are zero. In this illustration every good is indifferent to p's mental state; only consumption and benefit transfer matter. Every good positively weights net benefit inflow into the practice it belongs to. Goods for practices with consumption positively weight consumption. In addition goods may weight flows that indirectly benefit or disadvantage their practice. The economic practice good $g_{[p]}$ in this illustration favours saving over spend.

[Insert Tables 2, 3 and 4 about here]

5.1 Results of the simulation: no decision making

Since goods, activities, and transfer rates are constant it is only mental state that evolves through time. However even in this simplified context we see striking intertemporal behaviour. We simulate

this practice system over a 10-year period. The evolution of net practice esteem $\varepsilon_{p,s}v_{p,s}$, engagements $\varepsilon_{p,s}$, excellences $\chi_{p,s}$, and practice saliences $m_{p,s}$ are shown in Figure 4. In the figure, the practices $\langle H\rangle$, $\langle F\rangle$, $\langle S\rangle$, and $[p]$ are denoted by HR, FR, SR and E. Levels of net esteem are shown in panel A. Levels rise steadily except where drops occur when engagements change. The greatest net esteem comes initially from the social practice, but at around time 7 the household role practice overtakes it. Panel B shows engagement levels. These alter discretely as levels of esteems change. The practices with the highest levels of net esteem have the highest engagements. Initially the two practices with the highest esteem, and hence the highest engagements, are F and S. At around year 2 this switches to H and S. Towards the end of the ten year simulation period the social role and household role practices have the highest esteems and hence the highest engagements.

[Insert Figure 4 about here]

In our scenario excellences (panel C) are increasing. The rate of increase depends on b_p and $\varepsilon_{p,s}$. $\chi_{p,S}$ increases most rapidly, despite a low value of b_p, because S has high engagement. The level of excellence of the household role practice increases rapidly from around year 7 after its engagement increases. Finally, panel D of the figure shows practice saliences. Initially distributed equally between practices, saliences of every practice except E decreases, although $\langle F\rangle$ decreases more slowly than the other practices. At around 2 years, when p becomes fully engaged with S, S's salience increases dramatically, while that of E and $\langle F\rangle$ fall towards the levels of the other practices. At time 7 engagements change leading to a massive rise in the salience of $\langle H\rangle$ and declines in H, E, and S. It is clear that mental state evolves in a complex manner. This leads to large intertemporal variation in decision outcomes.

5.2 Results of the simulation: with decision making

We now suppose that p must choose between three alternative states. The different outcomes result in different rates of benefit transfer between practices. These are specified Table 5. Outcome F favours the firm, outcome S favours the social practice, and outcome $[p]$ the economic practice. Entries in bold denote changes from the base case given in Table 2. In outcome F the firm reduces the value of the goods its sells to p's practices, and the salary paid to p, and increases its retained earnings. The value of consumption in p's practices is reduced. In outcome S the economic practice gives more to $\langle S\rangle$ to pass on to S for consumption. To compensate $[p]$ reduces savings and the flow to $\langle H\rangle$. In outcome $[p]$ the economics practice increases savings by reducing flows to $\langle S\rangle$ and $\langle H\rangle$ so that consumption is reduced.

[Insert Table 5 about here]

In this illustration (i) practice goods are fixed and (ii) the rankings induced by goods depends only on consumption and benefit transfer. Consequently, as these are fixed, practice based decisions in this illustration do not change though time: F and $\langle F\rangle$ always choose outcome F; S and $\langle S\rangle$ always chose outcome S; and H, $\langle H\rangle$, and E always chose outcome $[p]$. In a more general setting, for instance if goods were not indifferent to mental state, it is clear from the results in section 5.1 that outcomes could vary through time.

The ethical decision chooses which practice to take the underlying decision using the mechanism described in section 3.3. An ethical decision determines the probabilities, computed with equation 25, under which a practice is chosen to take a practice decision. Figure 5, panel A shows these probabilities when the ethical decision is made at times up to time 15. There is considerable variation over this period. Up to time 8, E is most likely to take the decision. However $\langle S\rangle$, which around time 8 has almost zero probability of taking the decision, is, by time 11, the most likely to do so. H, F, and $\langle F\rangle$, which at time 0 had significant probabilities of being selected as the mediating good have, by time 15, only very small probabilities of being selected.

[Insert Figure 5 about here]

Panel B of Figure 5 shows the probability of each outcome, given the time at which the ethical decision is taken. The probability of outcome F, for instance, is the sum of the probabilities that either F or $\langle F\rangle$ are chosen to take the underlying practice decision. Up until time 10 outcome $[p]$ is the most likely outcome. After time 10 outcome S is the most likely. Outcome F, favouring the firm, is always the least likely outcome. Its chance of selection declines from around 0.3 to around 0.01.

In this illustration the interaction of components of the simulation is complex, leading to subtle, and perhaps unexpected, results. A simpler version, with fewer components, would yield a more straightforward link between outcomes and the initial configuration. Practice saliences determine the outcomes of ethical decisions and hence the outcomes of the underlying decision. Saliences evolve towards practices with the highest engagement, and levels of engagements depend on the relative values of net esteem received by an individual (modified by levels of excellence and pressure). In the illustration small changes in net esteem can result in large, discrete, changes in levels of engagement, and hence to potentially large consequential changes in saliences, and through those to changes in outcomes. In the simulation the change in engagement around time 2 to full engagement with S causes the salience of S to increase markedly. Similarly the changes in engagements around times 7 and 9 cause further dramatic changes in saliences. These result

directly in the large swings in the probabilities of selecting the mediating good, and hence the outcome of the underlying decision

We see that even in this simplified example ethical decisions are complex and dynamic. The framework may have the potential to model some of the inconsistencies and puzzles in real life economic decision-making such as fixed-cost present bias reported in the intertemporal choice literature (Benhabib et al. 2010) and other paradoxes mentioned earlier in this paper.

6 Conclusions

We show that a practice framework founded in MacIntyre (1985) can best reflect multi-self aspects of individual decision making proposed in behavioural economics and finance literature. According to our framework there are three categorically distinct types of decisions. Practices have a good and make decisions according to that good; individuals make ethical decisions to select the practice good used to take an underlying decision; and they make lifestyle decisions about their engagement with the practices they belong to.

There are several innovative features in the proposed theoretical framework. First it permits individuals to possess heterogeneous and contradictory preference rankings. This helps explain seemingly irrational decisions that do not maximise utility in income or consumption. This is in line with experimental behavioural economics and finance. Secondly, it allows ethical considerations to dominate individual utility maximisation in income; this is consistent with behavioural economics, social choice decision rules and prospect theory. Thirdly, we can explain time inconsistent decisions and commitment problems as preference orderings and decisions alter over time. Our framework allows variation in optimal choices both over practices and time. Last, in our theoretical framework decisions are explicitly made in a social context, and not just in the individual vacuum of 'homo economicus'. In that sense it is consistent with behavioural decision making outcomes such as the case of the disposition effect and agency cost considerations. For these reasons, we believe our framework offers an important tool for modelling practical economic and financial decision making.

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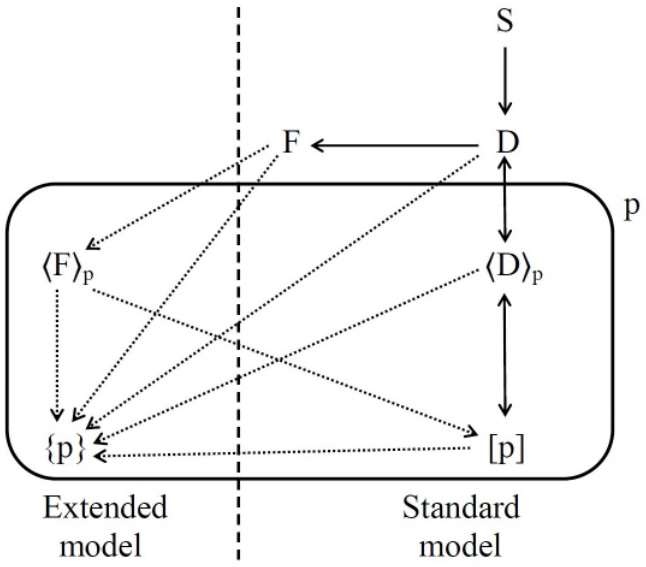
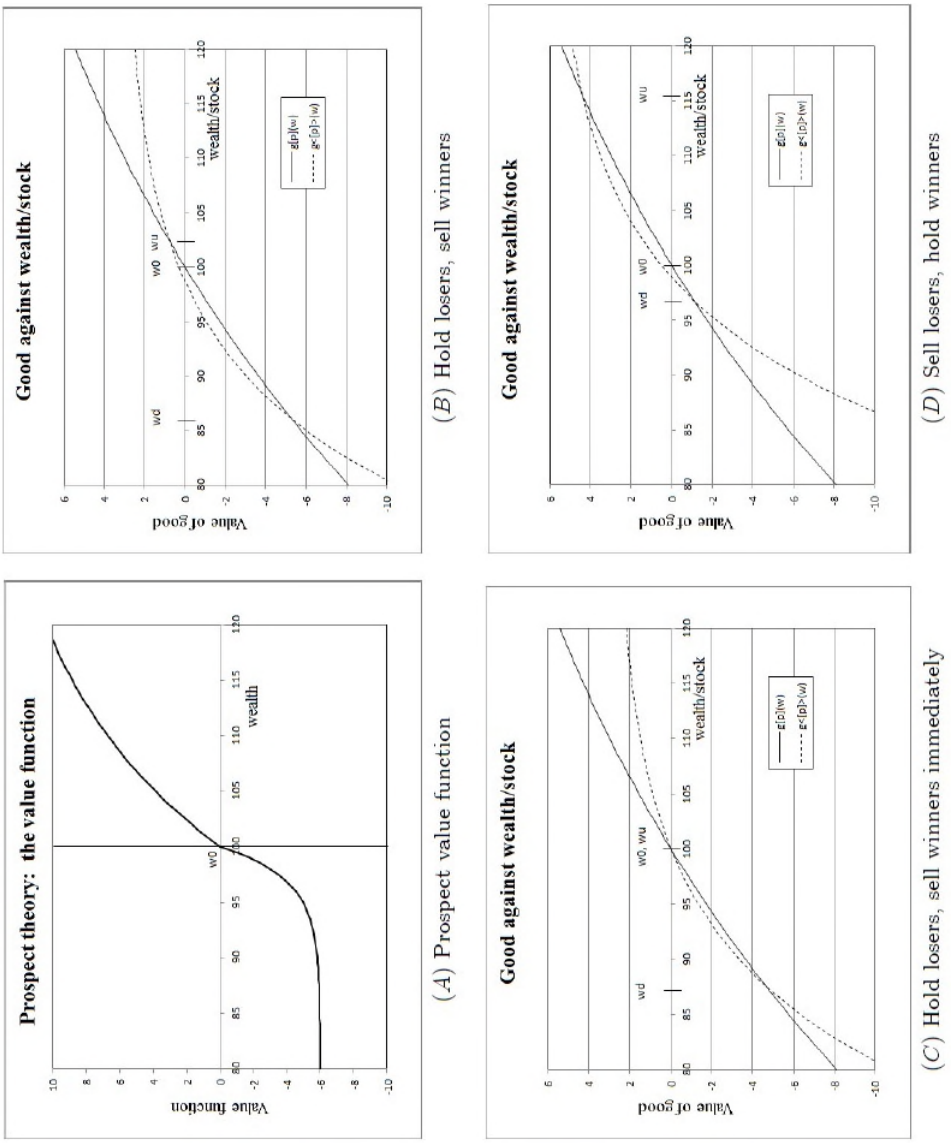
Figure 1 Mergers and acquisitions: a simplified practice representation



Notes:

F stands for the firm practice, S for shareholder practice,D for the director practice, $[p]$ is the economic practice, $\langle D\rangle_p$ and $\langle F\rangle_p$ are the director- and firm-related roles of individual p, and $\{p\}$ is the "extended model" economic practice deriving from the additional benefit received from both the $\langle D\rangle_p$ and $\langle F\rangle_p$.



(*A*) Prospect value function (*B*) Hold losers, sell winners

(*C*) Hold losers, sell winners immediately (*D*) Sell losers, hold winners

Figure 2 Prospect theory and practice theory

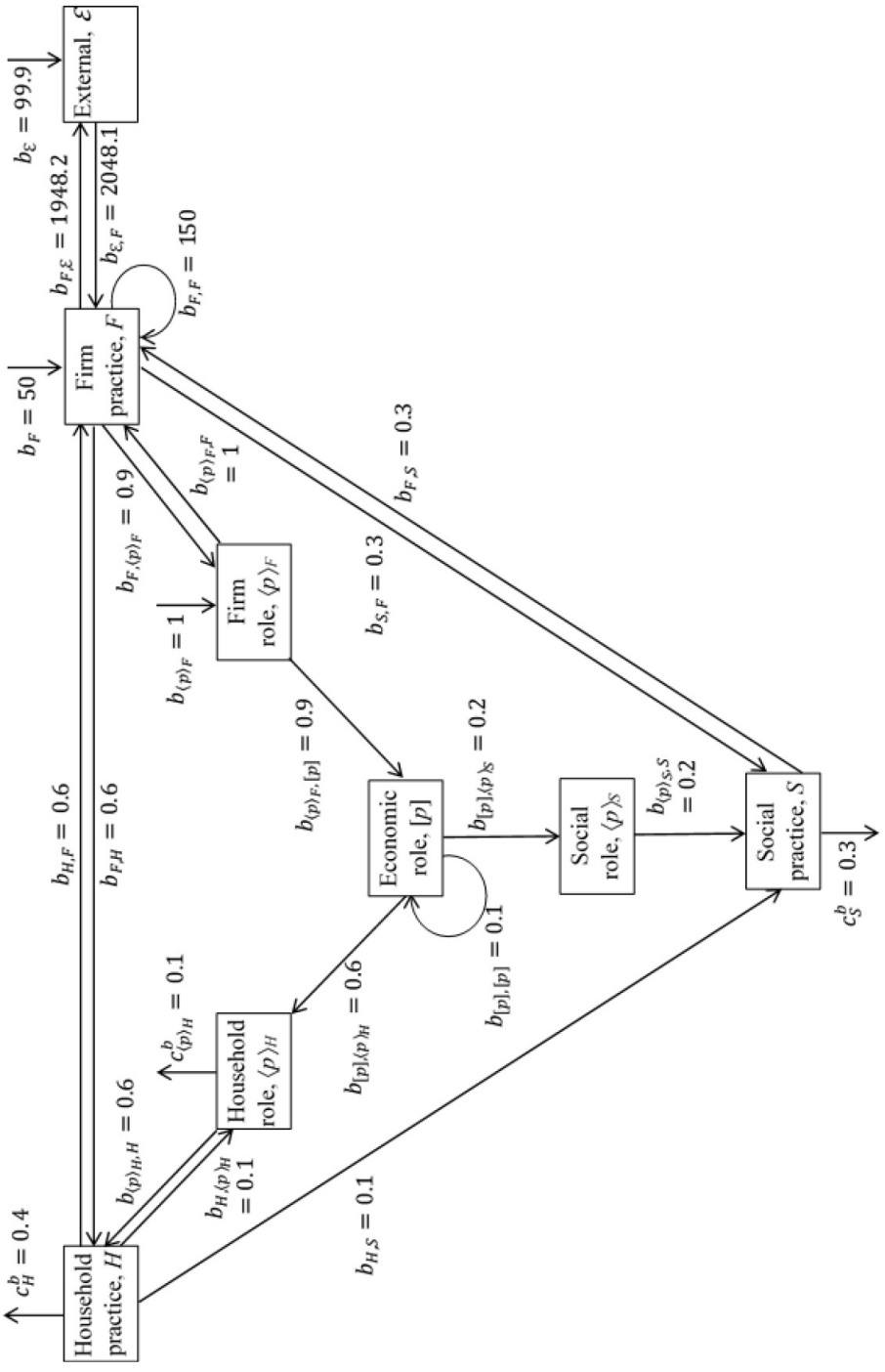


Figure 3 A simplified practice network

Table 1 Initial state of the system

Practice, s	Attributes of $\widehat{g}_s$ and $\widehat{a}_s$				Attributes of s		Attributes of p		
	$e(\widehat{g}_s)$	$b(\widehat{a}_s)$	$c^b(\widehat{a}_s)$	$c^e(\widehat{a}_s)$	N_s	ε_{min}	$m_p(0)$	$\chi_p(0)$	b_p
H	0.1	0	0.4	0	10	0.1	0.3	0.4	0.5
$\langle H \rangle$	0.1	0	0.1	0	1	0.1	0.3	0.5	0.5
F	0.1	1050	0	0	1000	0.1	0.3	0.2	0.2
$\langle F \rangle$	0.1	1	0	0	1	0.1	0.3	0.3	0.4
S	1.0	0	0.3	0	10	0.1	0.3	0.2	0.2
$\langle S \rangle$	1	0	0	0	1	0.1	0.3	0.4	0.6
$[p]$	0.1	0	0	0	1	0.1	0.3	0.2	0.2

Notes:

H is the household practice, S is the social practice and H is the firm practice. $\langle H \rangle$, $\langle S \rangle$, $\langle F \rangle$ correspond to the household-, social- and firm-roles undertaken by the individual p. $[p]$ is the economic practice, $e(\widehat{g}_s)$ stands for the esteem generated by the 'pure' good from engaging with a practice s and $b(\widehat{a}_s)$ is the benefit generated by the 'pure' activity in practice s, $c^b(\widehat{a}_s)$ and $c^e(\widehat{a}_s)$ are the rates of consumption of benefit and esteem required by the undertaking of a pure activity in practice s, N_s is the practice size, ε_{min} stands for minimum engagement, and $m_p(0)$ is the degree of salience between the practice and the individual. $\chi_p(0)$ corresponds to the rate of excellence (proficiency) of the individual p and b_p is the benefit rate received by p's personal practice.

Table 2 Rates of benefit transfer

Benefit transfer		To							
		H	$\langle H \rangle$	F	$\langle F \rangle$	S	$\langle S \rangle$	$\lfloor p \rfloor$	ε
From	H	0	0.1	0.6	0	0.1	0	0	0
	$\langle H \rangle$	0.6	0	0	0	0	0	0	0
	F	0.6	0	150	0.9	0.3	0	0	1948.2
	$\langle F \rangle$	0	0	1	0	0	0	0.9	0
	S	0	0	0.3	0	0	0	0	0
	$\langle S \rangle$	0	0	0	0	0.2	0	0	0
	$\lfloor p \rfloor$	0	0.6	0	0	0	0.2	0.1	0
	ε	0	0	2048.1	0	0	0	0	0

Notes:

H is the household practice, S is the social practice and H is the firm practice. $\langle H \rangle$, $\langle S \rangle$, $\langle F \rangle$ correspond to the household-, social- and firm-roles undertaken by the individual p. $[p]$ is the economic practice and $\mathcal{E}$ stands for external world where $p \notin \mathcal{E}$.

Table 3 Urgencies, powers and legitimacies

Urgencies		To							W	L
		H	$\langle H \rangle$	F	$\langle F \rangle$	S	$\langle S \rangle$	$[p]$		
From	H	0	1	0	0	0	0	0	0.5	0.5
	$\langle H \rangle$	0	0	0	0	0	0	1	0.5	0.5
	F	1	0	0	1	1	0	0	0.5	0.5
	$\langle F \rangle$	0	0	1	0	0	0	0	0.5	0.5
	S	1	0	0	0	0	1	0	0.5	0.5
	$\langle S \rangle$	0	0	0	0	0	0	1	0.5	0.5
	$[p]$	0	0	0	1	0	0	0	0.5	0.5

Notes:

H is the household practice, S is the social practice and H is the firm practice. $\langle H \rangle$, $\langle S \rangle$, $\langle F \rangle$ correspond to the household-, social- and firm-roles undertaken by the individual p. $[p]$ is the economic practice, W stands for power and L for legitimacy.

Table 4 Specification of the pure goods

g_s	Weights, +1		Weights, -1
	Consumption	Benefit Transfers	Benefit Transfers
g_H	c^b_H,$c^b_{\langle H\rangle}$	$b_{F,H}$,$b_{\langle H\rangle,H}$	$b_{H,F}$,$b_{H,\langle H\rangle}$,$b_{H,S}$,$b_{[p],\langle S\rangle}$
$g_{\langle H\rangle}$	$c^b_{\langle H\rangle}$,c^b_H	$b_{[p],\langle H\rangle}$,$b_{H,\langle H\rangle}$	$b_{\langle H\rangle,H}$,$b_{[p],\langle S\rangle}$
g_F		$b_{H,F}$,$b_{\langle F\rangle,F}$,$b_{S,F}$,$b_{F,F}$	$b_{F,H}$,$b_{F,\langle F\rangle}$,$b_{F,S}$
$g_{\langle F\rangle}$		$b_{F,\langle F\rangle}$,$b_{F,F}$	
g_S	c^b_S	$b_{H,S}$,$b_{\langle S\rangle,S}$,$b_{F,S}$	$b_{S,F}$
$g_{\langle S\rangle}$	c^b_S	$b_{[p],\langle S\rangle}$	$b_{[p],\langle H\rangle}$
$g_{[p]}$		$b_{\langle F\rangle,[p]}$,$b_{[p],[p]}$	$b_{[p],\langle H\rangle}$, $b_{[p],\langle S\rangle}$

Notes:

s stands for practice, H is the household practice, S is the social practice and H is the firm practice. $\langle H\rangle$, $\langle S\rangle$, $\langle F\rangle$ correspond to the household-, social- and firm-roles undertaken by the individual p. $[p]$ is the economic practice, b stands for benefit, c for consumption and $g_{(.)}$ stands for pure goods.

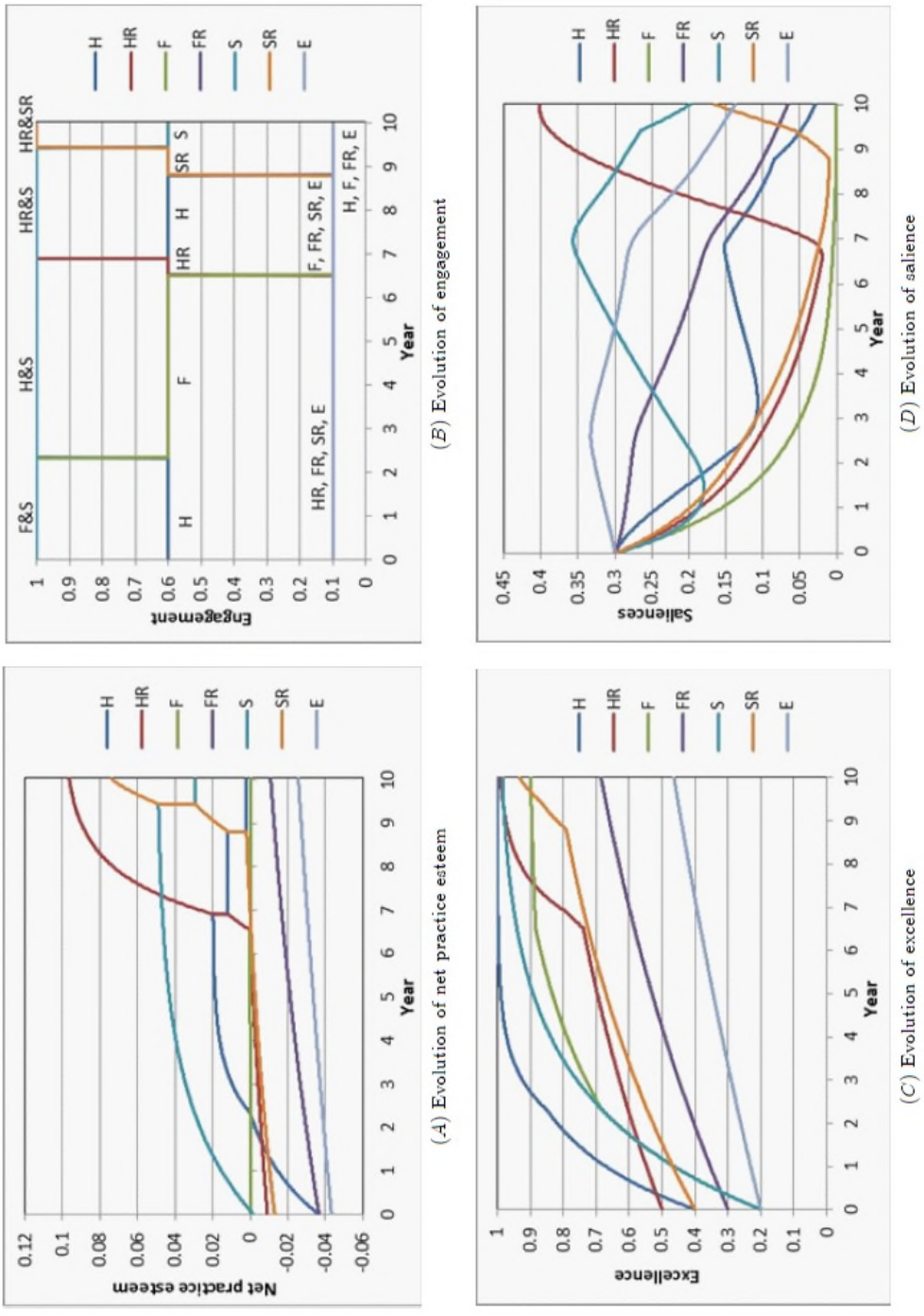


Figure 4 Evolution of attributes in the simulation

Table 5 Decision outcomes / Rates of benefit transfer

Outcome F		To							
		H	$\langle H \rangle$	F	$\langle F \rangle$	S	$\langle S \rangle$	$[p]$	c^b
From	H	0.0	0.1	0.6	0.0	0.1	0.0	0.0	**0.3**
	$\langle H \rangle$	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	F	**0.5**	0.0	**150.3**	**0.8**	**0.2**	0.0	0.0	0.0
	$\langle F \rangle$	0.0	0.0	1.0	0.0	0.0	0.0	**0.8**	0.0
	S	0.0	0.0	0.3	0.0	0.0	0.0	0.0	**0.2**
	$\langle S \rangle$	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
	$[p]$	0.0	0.6	0.0	0.0	0.0	0.2	**0.0**	0.0

Outcome F. Favours the firm practice.

Outcome S		To							
		H	$\langle H \rangle$	F	$\langle F \rangle$	S	$\langle S \rangle$	$[p]$	c^b
From	H	0.0	0.1	0.6	0.0	0.1	0.0	0.0	**0.3**
	$\langle H \rangle$	**0.5**	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	F	0.6	0.0	150.0	0.9	0.3	0.0	0.0	0.0
	$\langle F \rangle$	0.0	0.0	1.0	0.0	0.0	0.0	0.9	0.0
	S	0.0	0.0	0.3	0.0	0.0	0.0	0.0	**0.5**
	$\langle S \rangle$	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
	$[p]$	0.0	**0.5**	0.0	0.0	0.0	**0.4**	**0.0**	0.0

Outcome S. Favours the society practice.

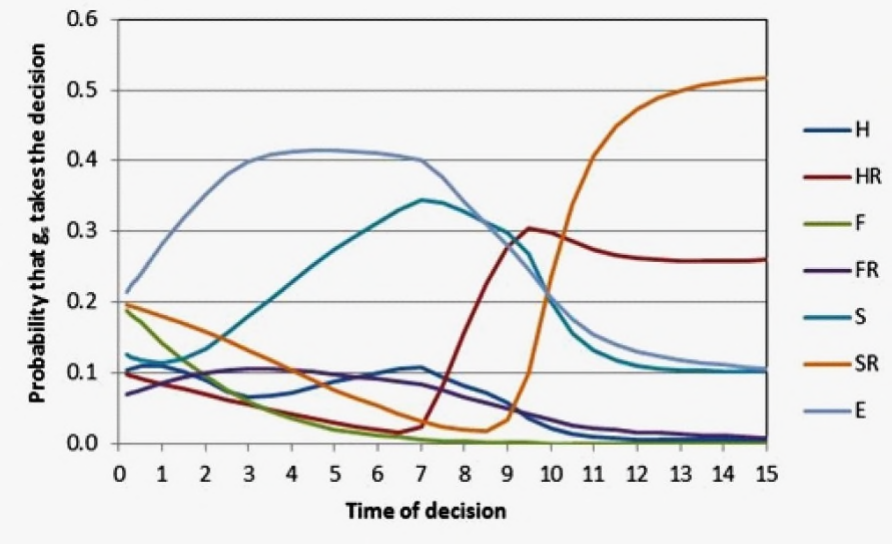
Outcome $[p]$		To							
		H	$\langle H \rangle$	F	$\langle F \rangle$	S	$\langle S \rangle$	$[p]$	c^b
From	H	0	0.1	0.6	0	0.1	0	0	**0.3**
	$\langle H \rangle$	**0.5**	0	0	0	0	0	0	0.1
	F	0.6	0	150.0	0.9	0.3	0	0	0
	$\langle F \rangle$	0	0	1	0	0	0	0.9	0
	S	0	0	0.3	0	0	0	0	**0.2**
	$\langle S \rangle$	0	0	0	0	**0.2**	0	0	0
	$[p]$	0	**0.5**	0	0	0	**0.1**	**0.3**	0

Outcome $[p]$. Favours p's economic practice.

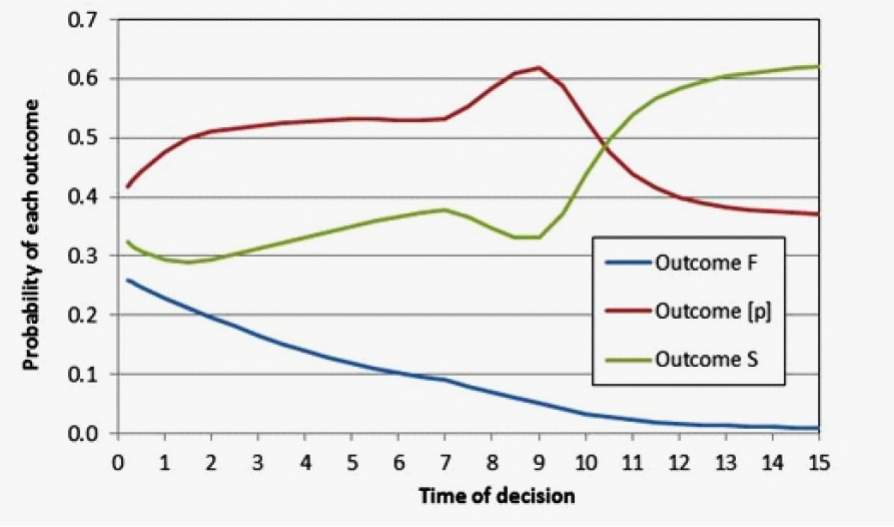
Notes:

H is the household practice, S is the social practice and H is the firm practice. $\langle H \rangle$, $\langle S \rangle$, $\langle F \rangle$ correspond to the household-, social- and firm-roles undertaken by the individual p.$[p]$ is the economic practice and c^b is the rates of consumption of benefit.

Figure 5. Probabilities of outcomes through time.



Panel A: Probabilities of selecting each $g_s$as the mediating good.



Panel B: Probability of each outcome of the underlying decision.

Notes:

H is the household practice, S is the social practice and H is the firm practice. HR, SR and FR correspond to the household-, social- and firm-roles undertaken by the individual p. $[p]$ is the economic practice.