Computing Job Satisfaction with Social Comparison Process : an Agent-Based Approach

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Abstract—In this article we propose a brief overview of *Happywork*, a multi-agent based model of job satisfaction inspired by well established psychosocial theories. We focus here on the cognitive dimension of job satisfaction that will be built from work features. The model is intended to model and simulate the core mechanisms that underlie individual evaluation of the job. We present here the model and some preliminary results that show significant consequences of job enhancement policy in term of comparison outcome.

I. Introduction

Work is the activity in which people spend most of their daylight time. According to opinion survey regarding life domains, job often comes at the top ranking in terms of subjective importance [4] and job satisfaction is one of the strongest predictor of overall happiness [7]. Moreover, the interest in job satisfaction has recently increased when more firms and governments realize the importance of work-related illnesses. Many reports (e.g. [41]) point out the increasing number of psychosocial risks at work, including musculoskeletal disorders, depression or burn-out. These clinical consequences are usually associated with typical behavioural patterns - e.g. absenteeism, withdrawal behaviour, quitting or job dissatisfaction [14] - that non only affect the firm but also send a warning sign about employees' psychophysical condition.

In this article we focus on mechanisms that lead someone to judge his/her work more or less satisfying. By contrast with many normative approaches, our methodology relies on *psychomimetism* [21] : we want our model to derive from well-established (mainly from human experiments) theories in social psychology, taking therefore a rather descriptive approach.

A. Defining Job Satisfaction

Job satisfaction is roughly about "how people feel about their jobs and different aspects of their jobs [...] the extent to which they like (satisfaction) or dislike (dissatisfaction) their jobs." [35]. The seminal work of Locke [26] goes further to explain the content of this *feeling*, that is: "the pleasurable emotional state [i.e. job satisfaction] resulting from the appraisal of one's job achieving or facilitating one's values." As the

new direction initiated by Easterlin [8], job satisfaction field of study lies on the subjective experience, either "feelings" about or "appraisal" of the job. Although there is a relative consensus about the nature of job satisfaction, there are many controversies regarding the content and area of influence of this subjective reactions to job conditions. In this work we followed an attitudinal approach.

B. The attitudinal approach of job satisfaction

In this approach, job satisfaction is mostly conceptualized as an *attitude* toward the job [35]. Here, attitude refers to Allport's view of a "mental state of readiness" that will influence the individual's response to a social object and all related objects and situations [2]. Following Hulin & Judges [17] this job attitude have three main components : cognitive (evaluative), affective (or emotional), and behavioural.

1) Cognitive dimension: It focuses on information processing based on job features [10]. Among many of these cognitive approaches, we find Social Information Processing [31], Value-Based Evaluation [26], input/output based judgment (e.g. the Cornell Model [18]) and Needs Based Judgment (e.g. the Job Characteristics Model [12]). The job attitude is computed through a comparative evaluation of job features, i.e. an aggregation of perceived discrepancies between job features and a set of standards (referents) [5]. These referents could be alternative situations (lived in the past or by others or even mentally experienced ones [23]) or abstract standards (values, needs, etc.).

2) Affective dimension: It includes affective response at work [20], emotional responses to job events [43], personality bias and interaction between affective and cognitive evaluation while at work [42]. However, several authors warn about the speculative content of mechanisms involved in emotion at work and their links with cognitive reaction to job events and features. Emotion and cognition are intimately related to one another, but no consensus emerges on their respective roles in job satisfaction formation [19].

3) Behavioural dimension: It is about how job attitude influence the subject's behaviour and actions. Therefore, it is of great interest since a good understanding of the relation between attitude and behaviour can provide insights to improve

organization outcomes [1]. Note that this component is mostly studied as a consequence rather than as an antecedent of job satisfaction: for instance, one will study if a very unsatisfied employee will under-perform or be ill more frequently [14].

C. Related Works in agent-based Simulation (ABS)

While many models of opinion dynamics have been proposed in the ABS, only few of them deal with attitudes in the psychosocial sense we defined above. Most of these attitudes are unidimensional (modelled with one vector x, each component x_i denotes the opinion of agent i), and treated as an opinion like in the bounded confidence framework [6] [15]. This is problematic for job satisfaction, as our attitudinal approach makes the distinction – well established in social psychology – between an opinion (verbal, external) and an attitude (three dimensional, internal). Moreover, as recalled above, an attitude is strongly multi-dimensional, based on several components and several features.

Some models are inspired by psychosociological theories [22] and some of them incorporate multi-dimensionality [40]. However, though they model the resulting changes in attitude (usually through communication and diffusion), they do not consider the inner mechanism that builds the attitude. In other words, the attitude formation is black-boxed, while here we aim to open the box in order to understand and study the determinants of job satisfaction. Hence, our model is not only to be inspired by psychosociological theories: we want to *implement* them (in the sense of [21]). As for agent interactions, we go beyond diffusion or communication by modelling a complete social comparison process, as it as been shown by the literature to be a crucial component of job attitude [9].

Finally, our mid-term / long-term goal is to provide a decision-aid tool for managers that aim to improve job satisfaction within their firms. Therefore, we need a rich and realistic enough model. In particular we must incorporate the elements (e.g. job conditions,...) we find in actual firm organization and that manager will seek to adjust.

D. Our approach to job satisfaction : the HappyWork framework

As stated before, we follow here an attitudinal approach. Moreover, we will focus only on the cognitive dimension of job attitude, for two main reasons. First, most of the surveys and data available on job satisfaction only capture the cognitive dimension [42]. The affective one is difficult to measure and to model at the moment [10]. Second, even if behavioural dimension is a mid-term/long-term goal of our project, it implies to include a work-at-the-firm dynamics and a firm organizational model that are out of scope for this paper.

Our approach for job satisfaction, we call the *HappyWork framework*, is based on subjective feature evaluation and comparison process with standards. If we take the point of view of organizational psychology and econometrics, the features will be the characteristics of the job, and concern the job at different levels like work load, demand for creativity,

autonomy, salary, etc. They are subjective perceptions of the job and could be accessible through surveys.

Defining standards is a difficult task, as there is no accepted consensus on their type and content: in Locke's value-percept model [25], standards are personal values; in Adam's equity based model, standards are others' job content; in Cornell's model [34] standards are past experiences and social values. Michalos [27] tried to synthesize these approaches in his multi-discrepancy theory (MDT) and proposed several comparison couples like self/wants, self/others, self/past best, etc. From our review of this literature, we have selected two types of standards and hence *two types of comparison* :

- a *social comparison* where a subject compare his/her job situation with some other individuals (denoted as *social referents*)
- an *historical comparison* where a subject compare his/her job situation with the ones he/she had in the past (denoted as *past referents*).

To these comparison processes, we add a *third component*: the *direct effect* that represents a direct evaluation of job features. This component is intended to capture individuals and environment differences, like the interaction between work and family/private life and job features' impacts on health or on the fulfilment of one's needs.

The Happywork framework is summarized in the Figure 1 below.
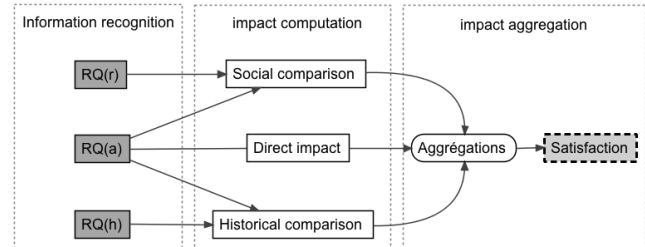

Fig. 1: The HappyWork Framework : cognitive process of job evaluation resulting in job satisfaction

At first, agent a acquires information about the job and comparison standards: a job feature perceptions vector $RQ(a)$, the job features for referent r $RQ(r)$ and past job features $RQ(h)$. Once the three cognitive sub-processes (social, historical and direct) have been performed, a final aggregation can be done to obtain the overall job satisfaction (corresponding to the answer to a question like :"overall, are you satisfied with your job"). This is the general modelling framework we propose to get a cognitive model of job satisfaction that will be well-grounded on social psychology. However, in this paper, we will describe and study the *social comparison* component only.

Finally, in HappyWork, we promote a *data-driven approach*, in order to account for real data deriving from field surveys. Thanks to our partner Technologia, we were able to use some of their questionnaires and surveys to feed our agents at

initialization, and study their job satisfaction dynamics (see section III-A below on data collection).

II. AGENT-BASED MODEL OF JOB SATISFACTION THROUGH SOCIAL COMPARISON

A. Model inputs and initialization

Let A be the set of agents in the simulation. Let $Q = \{q_1, \ldots q_n\}$ be the set of *job characteristics*, these characteristics being sorted out in a set of *job dimensions* $d \in D = \{d_1, \ldots d_m\}$. Q and D will be provided by the questionnaire we aim to study. Hence every agent $a \in A$ is initialized with values $RQ(a) = [q_{1a}, \ldots q_{na}]$ that encode his/her subjective job feature perception – namely their response to the questionnaire on each feature q_i. For instance, subjects were asked to evaluate their agreement in a scale from 1 to 4 to statements like : "Your job demand to work fast", "In my job, I have to learn new things" or "My colleagues are professionally competent". $RQ(a)$ could be continuous or an integer for ordinal data (like in Likert scales [24]).

Note that there is a *direct and monotonous link between satisfaction and questionnaire response values*. Whether ordinal (Likert) or continuous, Q is designed so that the highest the value of q_{ia}, the highest the (subjective) satisfaction of a is on characteristic q_i.

B. Discrepancy evaluation

The social comparison implies a computation of the discrepancies $\Delta(a, r)$ between an agent and his referents where r denotes one particular referent chosen by a. We have:

$$\Delta(a, r) = [\delta(a, r, q_1), \ldots, \delta(a, r, q_n)]$$

where, $\delta(a, r, q) \in [-1; 1]$ computes the discrepancy between a and r on feature q. $\delta(a, r, q) > 0$ means that a feels to be better than r on characteristic q ; when $\delta(a, r, q) < 0$ we have the opposite, that is, a feels to be worse than r on q; and if $\delta(a, r, q) = 0$, a feels similar to r on q.

Let $min(q_i)$ and $max(q_i)$ be respectively the minimal and maximal values of question q_i in the input data set. Then :

$$\delta(a, r, q_i) = \frac{q_{ia} - q_{ir}}{max(q_i) - min(q_i)} \qquad (1)$$

As one can notice in equation 1, δ is not a distance function; in particular it is not symmetrical.

C. Social comparison

For social comparison specification we take our inspiration from well established psychological field of social comparison (see [38] for a review). In direct line with Festinger's seminal work, social comparison is conceptualized as a mean to achieve a self-evaluation in a particular social environment [37]. Our social comparison mechanism is inspired by *Selective Accessibilty Model (SAM)* from Mussweiler [28][29][30].

According to Mussweiler, people compare with each other using three main processes :

1) the subject a uses a set $RS(a)$ of referents as a basis for the comparison ;

2) for each referent $r \in RS(a)$, if a feels similar enough with r, then he/she engages the comparison process

3) at this stage two different sub-processes might occur: *assimilation*, when a feels very close to the referent r and seeks similar features with him, or *contrast*, the opposite case when a feels different and will focus then on contrasting features with r.

Hence, our process of social comparison can be modelled as a sequence of *three distinct steps*: referent and information selection, similarity hypothesis testing, and assimilative / contrastive interpretation of comparison content. Let us now detail these three steps.

1) Referent selection: Classical definition of social referent encompass closeness and similarity, e.g. [9] [37]. While these concepts have no clear definitions, referents in work organization are basically the people we interact with [16][33], colleagues [32] and generally people in close environment [11]. In absence of data regarding the real social network, we decide as a preliminary step to randomly assign for each subject a a set $RS(a)$ of referents, with cardinality RN:

$$\forall a \in A \quad RS(a) = \{r_1, \ldots, r_{RN}\}$$
$$\forall k \in \{1, \ldots, RN\} \, r_k = RandomAgent(A, RS(a)) \qquad (2)$$

where $RandomAgent(A, RS(a))$ returns a randomly picked agent from A that is not already in $RS(a)$. We denote $RefSort$ the sorting probability for this random process.

2) Similarity hypothesis: In this step, agent a must decides whether it is close enough to referent r. To do so, a computes $modeInit(a, r) \in [0; 1]$ as the number of features on which a and r have different values (i.e. do not share the same feeling on this job characteristic). Hence, 0 means a complete similarity, and 1 a complete dissimilarity. However, following Mussweiler [29], $modeInit(a, r)$ is not computed on the entire job feature set. In fact, people typically select few salient information about their referents to engage in a basic, spontaneous and preliminary comparison process. Because these salient information are priming stimulus, they should be defined by their accessibility [29]. We denote this salient feature set $SF(Q)$, typically the employment conditions, like wage, working hours, status, years of service, etc. Then $modeInit(a, r)$ would be the proportion of features in $SF(Q)$ where a and r differ.

If $modeInit(a, r)$ exceeds a given *deflection threshold* $\sigma^{deflect}$, the comparison target is too dissimilar. In that case, the referent is deflected [36] and no comparison occurs. Otherwise, the similarity hypothesis is supported and a moves to the third step.

3) Assimilation and contrast outcomes: According to SAM theory, comparison outcome depends on comparison content and "on what information is cognitively accessible" [38]. Content is defined by the *direction of comparison*, namely *downward* when a compares his/her self with someone he/she feels to be worse off or *upward* comparison for the opposite. SAM conceived accessible information as priming stimulus focusing on similarity or dissimilarity. The model posits that if

someone is *primed* to insist on similarities with the comparison target, then assimilation effect is likely to occur. On the contrary, if someone is *primed* to insist on dissimilarities with the comparison target, then contrast effect is likely to occur [36][29].

Moreover, assimilation tends to increase/decrease a's evaluation on feature q as a result of comparing with someone better/worst on this feature q [44]. Contrast typically render opposite consequences, that is a decrease/increase of self-evaluation when comparing with someone better/worst off. This could be summarized in Table I below, where $IC(a, r, q) \in [-1; 1]$ is the outcome of a's comparison with referent r on feature q. $IC(a, r, q) > 0$ means that a's comparison with r will tend to increase a's satisfaction on feature q. $IC(a, r, q) < 0$ means that a's comparison with r will tend to decrease a's satisfaction on feature q.

TABLE I: Assimilation and contrast outcomes

	r is better ; $\delta(a, r, q) < 0$	r is worse ; $\delta(a, r, q) > 0$
Assimilation	$IC > 0$	$IC < 0$
Contrast	$IC < 0$	$IC > 0$

The comparison process is conducted as below :

- If subject a feels similar enough to r, that is if $modeInit(a, r) < \sigma^{assimil}$, then a performs an assimilation comparison. $\sigma^{assimil}$ is called the *assimilation threshold*, it represents the minimum proportion of similar features – taken from the set $SF(Q)$ of salient features – between a and its referent r to trigger an assimilation process. In that case, following Table I, we compute the impact $IC(a, r, q)$ as $IC(a, r, q) = -\delta(a, r, q)$. However, several sociopscyhologists [44][29] have found that comparison often exhibits mixed - assimilation *and* contrast - effect even though someone feels very close to comparison target. Therefore the final impact during assimilation becomes:

$$IC(a, r, q) = \delta(a, r, q_i) \times \left(1 - \frac{simil(a, r)}{\alpha^{transfer}}\right) \quad (3)$$

where $simil(a, r)$ computes the overall similarity between a and r as the proportion of features on which a and r feel similar, here taken on the entire feature set Q. $\alpha^{transfer}$ defines the minimum required similarity to ensure the assimilation effect will occur : at the contrary, if $simil(a, r) < \alpha^{transfer}$ then $1 - \frac{simil(a, r)}{\alpha^{transfer}} > 0$ and so IC and δ will have the same signs, denoting a contrast process (see Table I).

- Otherwise, if $modeInit(a, r) \geq \sigma^{assimil}$, the contrast comparison occurs and, following again Table I, we have $IC(a, r, q) = \delta(a, r, q) \cdot dissim(a, r)$ where $dissim(a, r) = 1 - simil(a, r)$ computes the overall similarity between a and r.

The complete impact comparison is summarized in the algorithm below :

Algorithm 1 *Comparison impact* computation

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for all $r \in RS(a)$ **do**
  if $modeInit(a, r) > \sigma^{deflect}$ **then**
    bypass r and **continue**
  else
    if $modeInit(a, r) < \sigma^{assimil}$ **then**
      for all $q \in RQ(a) \cup RQ(r)$ **do** {Assimilation}
        $IC(a, r, q) = \delta(a, r, q_i) \times \left(1 - \frac{simil(a, r)}{\alpha^{transfer}}\right)$
      end for
    else
      for all $q \in RQ(a) \cup RQ(r)$ **do** {Contrast}
        $IC(a, r, q) = \delta(a, r, q) \cdot dissim(a, r)$
      end for
    end if
  end if
end for

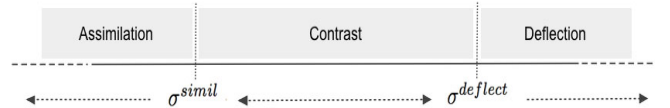Figure 2 displays the different comparison processes, according to σ values.

Fig. 2: Assimilation, contrast and deflection according to σ values

D. Social comparison aggregation

We must now compute the final social comparison outcome for agent a from its $IC(a, q, r)$ values. This is done through a sequence of multicriteria aggregations:

At first, because dimensions are the main facets of job satisfaction, we aggregate along the features of each dimension to obtain the aggregated comparison impact $ICD(a, r, d)$ on each dimension $d \in D$:

$$ICD(a, r, d) = WOWA_{q_j \in d}(IC(a, r, q_j)) \quad (4)$$

where $WOWA$ denotes the weighted ordered weighted average multi-criteria aggregation operator [39]. Then, all the referents $r \in RS(a)$ will be aggregated to get the overall comparison impact on dimension d, $ICA(a, d)$:

$$ICA(a, d) = OWA_{r \in RS(a)}(IC(a, r, d)) \quad (5)$$

where OWA denotes the ordered weighted average multi-criteria aggregation operator [45]. We do not need a WOWA here, as we have no information on the subject preference relations concerning his/her referents.

People are not equally sensitive to social comparison, they could react more or less to comparison impacts depending on their social comparison orientation (SCO) [3] or their

emotional arousal. Thus, we add a non-linear sigmoid transformation of the comparison impact aggregation (ICA):

$$CompSoc(a, d_i) = \tanh\Big(\rho_a \cdot ICA(a, d_i)\Big) \qquad (6)$$

Hyperbolic tangent is used to saturate comparison impacts, while parameter ρ_a stands for the sensitivity to comparison for a. $CompSoc(a, d_i)$ is the job satisfaction for dimension d_i.

Finally, we compute the *final social comparison outcome* $SocSat(a) \in [-1; 1]$ with a WOWA aggregation of the job dimension satisfactions 6) :

$$SocSat(a) = W \overset{|D|}{\underset{i=1}{OW}} A\big(CompSoc(a, d_i)\big) \qquad (7)$$

III. AGENT BASED SIMULATION EXPLORATION OF JOB SATISFACTION SOCIAL COMPONENT

Multi-agents based simulations are very tricky to explore and even more with a global descriptive perspective. Given that our model is particularly detailed, the mechanisms underlying agent behaviour are not simplistic to explain. In this paper, we decided to restrict our analysis to a key element : the effects of the assimilative / contrastive mechanism.

A. Data collection and initialization process

The set A of agents is initialized from real word data coming from a manager's satisfaction survey conducted by our partner Technologia, within a big French company. There are 178 agents in this dataset, and all the questionnaires Q is made of Likert scales. There are 4 dimensions in D : the 3 Karasek dimensions – i.e. job control (JC), job demand (JD), and social support (SS) – and employment conditions (EC). Referent sorting probability function $RefSort$ is set to an uniform distribution within the agent set A.

B. Simulation protocol

The idea that leads the exploration of the model relies on understanding the impact of assimilation and contrast on final social comparison outcome (eq. 7). To do so, we aim to study three typical *psychosociological* profiles, that will be set through a combination of σ^{simil} and $\alpha^{transfer}$ values :

1) *High Assimilation (PHA)* : a conjunction of highly permissive "priming on similarity" (high threshold σ^{simil}) and a high orientation toward assimilation outcome (low $\alpha^{transfer}$). This profile represents a very high propensity to assimilate with someone else, and therefore will serve at gauging typical outcomes of quasi-systematic assimilation.

2) *Moderate Assimilation (PMA)* : the "priming on similarity" threshold remains high ($\sigma^{simil} = 0.6$) but the predisposition to assimilation outcome is lowered (higher $\alpha^{transfer} = 0.6$ so a contrasting counter-effect is more plausible).

3) *High Contrast (PHC)* : it represents a social comparison based on contrast, that is a low threshold of dissimilarity (priming on similarity is very restrictive) and keeping a high $\alpha^{transfer}$ to trigger contrast.

Table II displays the values that implement these 3 profiles in our simulations :

TABLE II: Profile parameters

	σ^{simil}	$\alpha^{transfer}$
High assimilation (PHA)	0.6	0.2
Moderate assimilation (PMA)	0.6	0.6
High contrast (PHC)	0.2	0.6

For each simulation, all agents are initialized with the same profile. All other parameters remain constant over simulations: namely, the initial set of referents is set to 10% of agent population, $\sigma^{deflect} = 0.8$, individual comparison orientation given by : $\forall a \in A \ \rho_a = 2$. For sake of simplicity, the OWA and WOWA operators are set to mean operators, and the weights for WOWAs are derived from feature and dimension weights available in the data set. For the Salient Features $SF(Q)$, we have the employment conditions, the seniority within the firm, and the employee qualification.

C. Analysis of static simulation

First of all, a static analysis has been carried out in order to evaluate the basic impact of parameters. We use a quartile representation of agent job satisfaction, where we computed the average of final social comparison outcomes within 4 groups, each of one corresponding to each quartile (from the $Q1$ quartile of 25% most satisfied to the $Q4$ of 25% least satisfied agents). We conducted 50 runs for each profile of the defined profile parameter and average the values over these runs to get the outputs shown below.

1) Assimilation vs contrast: The results are displayed in Table III, showing the proportion of contrast and assimilation in the comparison. For instance, a contrast value of 0.3 means that on average the agents feel to be in a contrasting position with 30% of their (non deflected) referents. We compute the assimilation proportion likewise. The deflection score is computed as the proportion of deflected referents. As expected, we observe clear tendencies depending on the profile we defined above. High and moderate assimilation (PHA & PMA) display assimilation to be more than twice often as contrast, when high contrast has a very high proportion (PHC) of contrast and almost no assimilation.

TABLE III: Proportion of assimilation and contrast

	Contrast	Assimilation
PHA & PMA	0.30	0.70
PHC	0.95	0.05

2) Link with declared satisfaction: For each profile, we get a different quartile distribution and we can compare it with the average declared (in the survey) job feature value on each quartile. The average is based on a Likert scale value transposition. The initial value of response statement is transposed in $[-1; 1]$. For example, on a Likert of 4 scales values are transposed as follow $\{1, 2, 3, 4\} \Rightarrow \{-1, -0.33, 0.33, 1\}$. As displayed in Table IV, we identified a correlation between

these declared feature values and propensity to assimilation or contrast. In fact, it appears that for PHA social comparison impact is inversely correlated to declared job feature values.

TABLE IV: Mean of job feature declared evaluations per quartile and profile

	Q1 & Q2 (Highest)	Q3 & Q4 (lowest)
PHA	0.17 (±0.4)	0.34 (±0.37)
PMA & PHC	0.37 (±0.34)	0.15 (±0.42)

This could be explained by the fact that, as we already mentioned in our model description, assimilation tends to reverse the sign of the comparison content – upward or downward (cf. Table I). Therefore, people with a high (low) job feature value tend to decrease (increase) their job attitude when they compare and assimilate with worse (better) subjects on this feature.

D. Simulation exploration based on scenarii

We present here an empirical exploration of simulation according to a simple scenario, based on organizational policies regarding job enhancement and design [13][35]. These policies are targeted at employees that suffer deprivation in work motivation within an organization. In our scenario, this can be improved by raising some job feature values in agent job representation $RQ(a)$, like task identity and variety, autonomy, or relation with others (job enrichment, see e.g. [12]).

In our simulation, the improvement occurs as follows: at each tick, after agents have compared themselves with their referents, the organization takes a set of NI agents and increases a number FI of their lowest feature values, and repeats this process at each tick until all agents have a job satisfaction level $SocSat$ above a threshold λ. In our experiments we set $\lambda = 0$.

First of all, we display in Table V the average of agents' job feature values along the 4 dimensions (EC, JC, JD and SS). We use the same transposition than in Table IV, but compute average feature values taken from dimension rather than from the entire set of feature. These values are calculated at the start of the simulation for line 1 while the lines 2 to 4 show average feature values at the end of the scenario for population of agent with profile PHA, PMA and PHC respectively. From start to end, dimension value indicators have actually been significantly raised as the result of job enhancement, but relatively less for PHA than for PMA and PHC. More over, the standard deviations are quit high for PHA compared with the other two profiles, suggesting that for many agents the satisfaction is much lower that this average and therefore these agents will not see much improvement. Pure assimilation seems to be a profile more difficult to improve.

Now, we show typical graphics of satisfaction dynamics in figures 3 below. These ones depicted information about final social comparison outcome, from lowest (red) to highest quartile (purple), that is the average of job satisfaction for

TABLE V: Policy impact on global job feature values per dimension for scenario with $NI = 0.04$ and $FI = 1$.

EC = employment conditions; JC = job control;
JD = job demand; SS = social support.

	EC	JC	JD	SS
Start (t=0)	−0.05 (±0.44)	0.18 (±0.14)	0.19 (±0.24)	0.74 (±0.1)
PHA end	0.52 (±0.50)	0.56 (±0.39)	0.58 (±0.39)	0.85 (±0.14)
PMA end	0.85 (±0.13)	0.90 (±0.10)	0.87 (±0.16)	0.87 (±14)
PHC end	0.73 (±0.08)	0.96 (±0.08)	0.96 (±0.08)	0.96 (±0.10)

each quartile including standard deviation. y axis depicted job satisfaction average level, and x axis displayed simulation ticks.

In Figure 3a (PHA profile), high assimilation process shows a persistent dispersion of satisfaction values, the gap between the four quartiles remains constant along the simulation. That means there is no real improvement on average and therefore the policy failed.

By contrast, in Figure 3c (PHC) corresponding to high contrast agents, we have a very different result : the gap between job satisfaction quartile is significantly reduced and at the end the attitudes increase for all the four quartiles, meaning a success in the policy. This was at the cost of the Q1 quartile (most satisfied) that have their satisfactions slightly reduced, thanks to the social comparison process.

As expected the moderate assimilation depicted in Figure 3b lies in between the other two cases. The gap is actually reduced (a sort of consensus on job satisfaction among the population) but there is no significant collective improvement : the most satisfied display a satisfaction decrease, and the worse off show a little improvement. In that case, it is difficult to assess if the policy succeeds or not.

We now investigate on transition flows over the λ parameter. Results in Table VI show that improvement is almost total in the high contrast context, while high and moderate assimilation show more mixed flows. Thus, in our high contrast, 100% of unsatisfied subjects become satisfied (move above λ) at the end of the scenario, and only 5% of the initially satisfied ones become unsatisfied (95% keep their positive job attitude). In assimilation profile agents show a greater resistance against job improvement : more of them remain in a negative satisfaction, less of them shift to a positive one. The resistance is slightly reduced when assimilation is only moderate.

TABLE VI: Transition flows for scenario 1

	Stay neg	Stay pos	pos → neg	neg → pos
PHA	0.38	0.9	0.1	0.62
PMA	0.22	0.8	0.2	0.78
PHC	0.0	0.95	0.05	1.0

To sum up, the more contrast you have, the better the improvement you will get, but the more organization has to invest on job enhancement policy. Whatever the profile is, aeast 80% of agents remain satisfied and at least 62%

(a) High assimilation

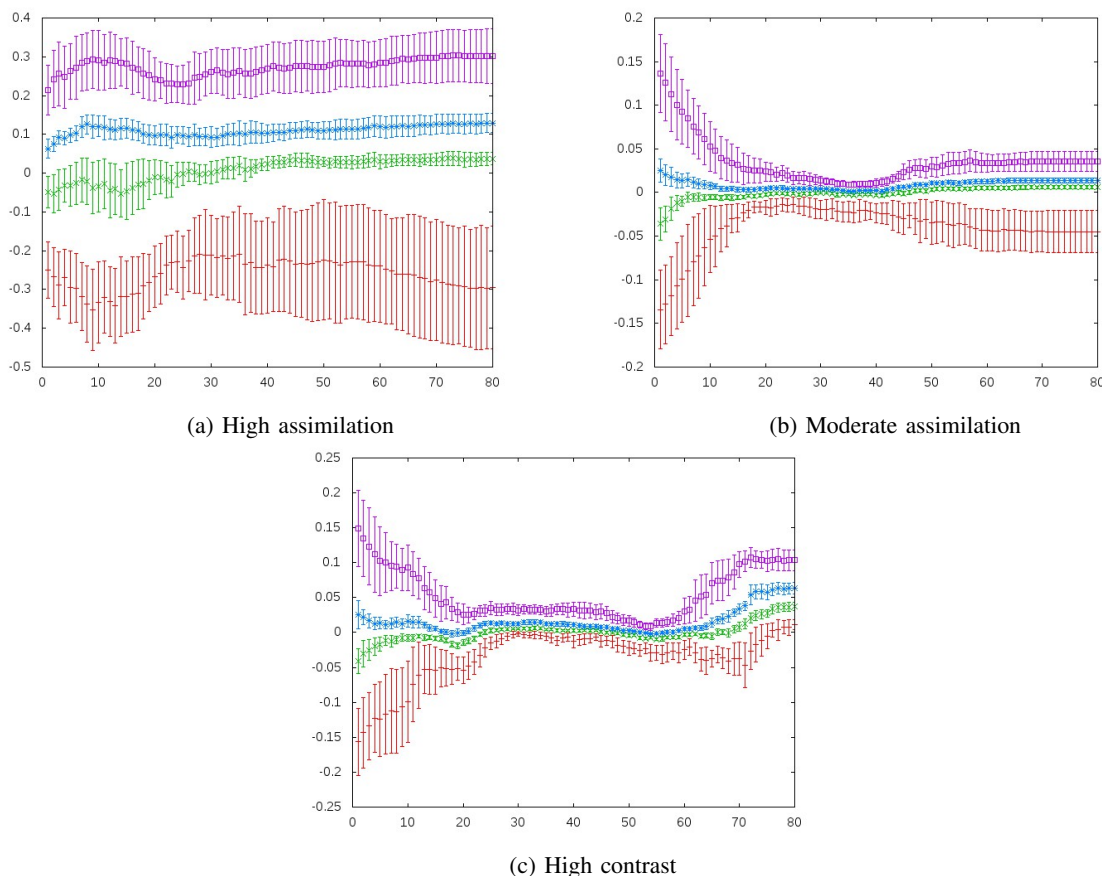(b) Moderate assimilation

(c) High contrast

Fig. 3: Simulation results from scenario 1

become satisfied. In High assimilation, we found the lowest improvements. As we shown in Table IV, the lowest quartile in PHA have initially the highest job feature values, so maybe there was not much to improve. More convincing, because of the sign reversal at the core of assimilation (remember Table I again), if a PHA agent's situation is improved so that he feels even better than his referent, that will have a negative impact on his social comparison outcome ($IC < 0$), thanks to assimilation.

IV. CONCLUSION

In summary, we explored consequences of social comparison on job evaluation. We showed that assimilation and contrast lead to very different outcomes in term of response to job content policy improvement. From an organizational point of view, job improvement could lead to unintended consequences. Nevertheless, these results needs further analysis to be confirmed. Along with a deeper sensitivity analysis of the parameters, we could improve the scenario by mixing job feature raises and diminutions, or changing referents over time (mimic a local re-organization of work processes). We also plan to explore more the cognitive profiles. For instance, we will study the behaviour of mixed agent population, made of different cognitive profiles (PHA, PMA and PMC). Nonetheless, we have shown in this preliminary paper how

our agent-based model could be used to assess a particular job improvement policy.

REFERENCES

[1] Icek AJZEN. Job satisfaction, effort, and performance: A reasoned action perspective. *Contemporary Economics*, 5(4), December 2011.
[2] Gordon W. ALLPORT. Attitudes. 1935.
[3] Bram P. BUUNK, Rosario ZURRIAGA, Jose M. PEIRO, Aukje NAUTA, and Isabel GOSALVEZ. Social comparisons at work as related to a cooperative social climate and to individual differences in social comparison orientation. *Applied Psychology*, 54(1):61–80, 2005.
[4] Andrew CLARK. Work, jobs and well-being across the millennium. In *International Differences in Well-Being*. Oxford University Press, Oxford, 2010.
[5] Reeshad S. DALAL. Job attitudes: Cognition and affect. In I. B. WEINER, N. SCHMITT, and S. HIGHHOUSE, editors, *Handbook of psychology: Vol. 12. Industrial and organizational psychology (2nd edn.)*. New York, 2012.
[6] G. DEFFUANT, D. NEAU, F. AMBLARD, and G. WEISBUCH. Mixing beliefs among interacting agents. *Advances in Complex Systems*, 3(01n04):87–98, 2000.
[7] Ed DIENER, Eunkook M. SUH, Richard E. LUCAS, and Heidi L. SMITH. Subjective well-being: Three decades of progress. *Psychological Bulletin*, 125(2):276–302, 1999.
[8] R.A. EASTERLIN. Does economic growth improve the human lot ? some empirical evidence. *Nations and households in economic growth*, (1):88–125, 1974.
[9] Leon FESTINGER. A theory of social comparison processes. *Human relations*, 7(2):117–140, 1954.
[10] Cynthia D. FISHER. Happiness at work. *International Journal of Management Reviews*, 12(4):384–412, 2010.

[11] Jerald GREENBERG, Claire E. ASHTON-JAMES, and Neal M. ASHKANASY. Social comparison processes in organizations. *Organizational Behavior and Human Decision Processes*, 102(1):22–41, January 2007.

[12] J. Richard HACKMAN and Edward E. LAWLER. Employee reactions to job characteristics. *Journal of Applied Psychology*, 55(3):259–286, 1971.

[13] J. Richard HACKMAN and Greg R. OLDHAM. Motivation through the design of work: Test of a theory. *Organizational behavior and human performance*, 16(2):250–279, 1976.

[14] David HARRISON, Daniel NEWMAN, and Philip ROTH. How important are job attitudes ? meta-analytic comparisons of integrative behavioral outcomes and tims sequences. *Academy of Management Journal*, 49(2):305–325, 2006.

[15] Rainer HEGSELMANN and Ulrich KRAUSE. Opinion dynamics and bounded confidence models, analysis, and simulation. *Journal of Artificial Societies and Social Simulation*, 5(3), 2002.

[16] R. HODSON. Workers comparisons and job satisfaction. *Social Science Quarterly*, 66(2):266–280, 1985.

[17] Charles L. HULIN and Timothy A. JUDGE. Job attitudes. In W. C. Borman, D. R. Ilgen, and R. J. Klimoski, editors, *Handbook of psychology: Industrial and organizational psychology, Vol. 12*, pages 255–276. John Wiley & Sons Inc, Hoboken, NJ, US, 2003.

[18] Charles L. HULIN, Mary ROZNOWSKI, and Donna HACHIYA. Alternative opportunities and withdrawal decisions: Empirical and theoretical discrepancies and an integration. *Psychological Bulletin*, 97(2):233–250, 1985.

[19] T A JUDGE and Ryan KLINGER. Job satisfaction and subjective well-being at work. In Michael EID and Randy J. LARSEN, editors, *The Science of Subjective Well-Being*. Guilford Press, 2008.

[20] Timothy A. JUDGE, CHarles L. HULIN, and Reeshad S. DALAL. Job satisfaction and job affetc. In *The Oxford Handbook of Industrial and Organizational Psychology*. Oxford University Press, New York, 2012.

[21] Jean-Daniel KANT. Modeling human cognition with artificial systems: some methodological considerations. pages 501–508. 1999.

[22] Johannes KOTTONAU and Claudia PAHL-WOSTL. Simulating political attitudes and voting behavior, October 2004.

[23] Louis LEVY-GARBOUA and Claude MONTMARQUETTE. Reported job satisfaction: what does it mean? *Journal of Socio-Economics*, 33(2):135–151, April 2004.

[24] Rensis LIKERT. A technique for the measurement of attitudes. *Archives of Psychology*, (140):1–55, 1932.

[25] E. A LOCKE. The nature and causes of job satisfaction. In *Handbook of Industrial and organizational psychology*, pages 1319–1328. Consulting Psychologists Press, Palo Alto, 1976.

[26] Edwin A. LOCKE. What is job satisfaction, September 1968.

[27] Alex C. MICHALOS. Multiple discrepancies theory (MDT). *Social Indicators Research*, 16(4):347–413, 1985.

[28] Thomas MUSSWEILER. Seek and ye shall find: antecedents of assimilation and contrast in social comparison. *European Journal of Social Psychology*, 31(5):499–509, 2001.

[29] Thomas MUSSWEILER. Comparison processes in social judgment: mechanisms and consequences. *Psychological review*, 110(3), 2003.

[30] Thomas MUSSWEILER, Katja RUTER, and Kai EPSTUDE. The ups and downs of social comparison: Mechanisms of assimilation and contrast. *Journal of personality and social psychology*, 87:832–844, 2004.

[31] Gerald R. SALANCIK and Jeffrey PFEFFER. A social information processing approach to job attitudes and task design. *Administrative Science Quarterly*, 23(2), June 1978.

[32] Claudia SENIK. Direct evidence on income comparisons and their welfare effects. *Journal of Economic Behavior & Organization*, 72(1):408–424, October 2009.

[33] P. P. SHAH. Who are employees' social referents ? using a network perspective to determine referent others. *Academy of Management Journal*, 41(3):249–268, June 1998.

[34] Patricia Cain SMITH, Lorne M. KENDALL, and Charles L. HULIN. *The Measurement of Satisfaction in Work and Retirement: A Strategy for the Study of Attitudes*. Rand McNally, 1969.

[35] Paul E. SPECTOR. *Job satisfaction: application, assessment, cause, and consequences*. SAGE, March 1997.

[36] Jerry SULS, Ren MARTIN, and Ladd WHEELER. Three kinds of opinion comparison: The triadic model. *Personality and Social Psychology Review*, 4(3):219–237, August 2000.

[37] Jerry SULS, Ren MARTIN, and Ladd WHEELER. Social comparison: Why, with whom, and with what effect? *Current Directions in Psychological Science*, 11(5):159–163, October 2002.

[38] Jerry SULS and Ladd WHEELER. Social comparison theory. In Paul A. M. van Lange, Arie W. Kruglanski, and Edward Tory Higgins, editors, *Handbook of theories of social psychology*. London, Royaume-Uni, 2012.

[39] Vicen TORRA. The weighted OWA operator. *International Journal of Intelligent Systems*, 12(2):153–166, 1997.

[40] Diemo URBIG and Robin MALITZ. Drifting to more extreme but balanced attitudes: Multidimensional attitudes and selective exposure. *ESSA, Toulouse*, 2007.

[41] Antoine VALEYRE, Edward LORENZ, Damien CARTRON, Pter CSIZMADIA, Michel GOLLAC, Miklos ILLESSY, and Csaba MAKO. Working conditions in the european union: Work organisation. Rapport d'enquête, European Foundation for the Improvement of Living and Working Conditions, 2009.

[42] H. M WEISS. Deconstructing job satisfaction: Separating evaluations, beliefs and affective experiences. *Human Resource Management Review*, 12(2):173–194, 2002.

[43] Howard M WEISS and Russell CROPANZANO. Affective events theory: A theoretical discussion of the structure, causes and consequences of affective experiences at work. *Research In Organizational Behavior*, 18(S 1):1–74, 1996.

[44] Ladd WHEELER and Jerry SULS. Assimilation in social comparison: Can we agree on what it is? *Revue internationale de psychologie sociale*, (1):31–51, 2007.

[45] R.R. YAGER. On ordered weighted averaging aggregation operators in multicriteria decisionmaking. *IEEE Transactions on Systems, Man and Cybernetics*, 18(1):183–190, January 1988.