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by

**Alex Coad
Martin Binder**

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Max Planck Institute of Economics
Evolutionary Economics Group
Kahlaische Str. 10
07745 Jena, Germany
Fax: ++49-3641-686868

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Causal linkages between work and life satisfaction and their determinants in a structural VAR approach[☆]

Alex Coad^{*,a,b,c}, Martin Binder^{a,d}

^aScience and Technology Policy Research Unit, University of Sussex, Falmer, Brighton, BN1 9SL, UK

^bRATIO, P.O. Box 3203, SE-10364 Stockholm, Sweden

^cDepartment of Business and Management, Aalborg University, Fibigerstræde 4, 9220 Aalborg Ø, DK

^dMax Planck Institute of Economics, Evolutionary Economics Group, Kahlaische Str.10, 07745 Jena, Germany

Abstract

Work and life satisfaction depend on a number of pecuniary and non-pecuniary factors at the workplace and determine these in turn. We analyze these causal linkages using a structural vector autoregression approach for a German sample of the working populace from 1984-2008.

1. Introduction

Most of the working populace spend half of their waking hours or more at their jobs most of the days of a week. It is thus no wonder that one's employment plays a big role in determining one's health and well-being. We unpick the causal relations between well-being and other life domains using data-driven structural (vector autoregressions) VARs. VARs have been recently applied to the study of subjective well-being (Becchetti et al., 2008; Binder and Coad, 2010; Bottan and Truglia, 2011). Using reduced-form VARs thus allows us to model the complex co-evolution of a number of interconnected variables, but cannot provide causal interpretation. We extend previous work by using a structural VAR approach

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*Corresponding author

Email address: a.coad@sussex.ac.uk (Alex Coad)

to assess the causal linkages between work and life satisfaction and a number of their most important workplace determinants.

2. Data

We analyze the co-evolution of a number of key workplace variables for the German Socio-Economic Panel (SOEP) household panel data set from 1984 to 2008. This well known data set collects information on a representative sample of the German populace in a wide range of domains of the respondents' lives (for more information see [Wagner et al., 2007](#); [Haisken-DeNew and Frick, 2005](#)). We use an unbalanced panel with a total of 200,813 observations (after discarding observations where respondents did not provide data for the variables used in our analysis; see [Table 1](#) for descriptive statistics). Since we are interested in causal linkages of life and work satisfaction at the workplace, we focus only on individuals who report being employed (with the majority being in full-time employment, 76%, and some individuals being in part-time or marginal employment statuses or training).

Our main variables of interest are as follows: We use an individual's life satisfaction as measure of overall well-being, where individuals are asked how satisfied, all in all, they are with their life at the moment. This question is answered on an 11-point Likert scale ranging from 0 (lowest satisfaction) to 10 (highest satisfaction). We also look more specifically into an individual's satisfaction with the job, measured similar to the life satisfaction variable. We also use a measure of (log) household income, which is deflated and adjusted for post-government transfers (taxes and transfers) and which we equalize using the International Experts' scale (i.e. dividing household income by the square root of household size, see, e.g., [Headey et al., 2004](#)).

A further variable of interest is an individual's health problems, which we operationalize with a composite variable created via principal component analysis and consisting of a satisfaction with health judgement and the (log) number of hospital days and doctor visits. The objective parts of this variable help in alleviating reservations about personality traits mediating the satisfaction with health judgment. Our measure accounts for $\rho = 47.96\%$ of the variance of the individual indicators (and the Kaiser-Meyer-Olkin (KMO) measure indicates acceptable fit).

Table 1: Summary statistics

| | (1) | | | |
|--------------------------|----------|----------|---------|--------|
| | mean | sd | min | max |
| Life satisfaction | 7.1614 | 1.6501 | 0 | 10 |
| Work satisfaction | 7.1303 | 2.0060 | 0 | 10 |
| Bad Health | 0.0000 | 1.1995 | -1.7341 | 8.2271 |
| Satisfaction With Health | 7.0637 | 2.0153 | 0 | 10 |
| log(hospital days) | 0.1743 | 0.6348 | 0 | 5.7714 |
| log(doc visits) | 1.4337 | 1.2834 | 0 | 5.9839 |
| Log(income) | 9.9743 | 0.4637 | 2.2477 | 14.923 |
| Hours worked | 39.3494 | 12.0475 | 0.2000 | 80 |
| Autonomy | 2.5401 | 1.2313 | 0 | 5 |
| Worries | 4.5315 | 0.9571 | 2.2216 | 6.6648 |
| Worry: Economy | 2.2359 | 0.6186 | 1 | 3 |
| Worry: Finances | 1.9192 | 0.6767 | 1 | 3 |
| Worry: Environment | 2.2125 | 0.6299 | 1 | 3 |
| Worry: Peace | 2.2011 | 0.6949 | 1 | 3 |
| Worry: Job Security | 1.6797 | 0.7162 | 1 | 3 |
| gender | 0.4399 | 0.4964 | 0 | 1 |
| age | 40.4009 | 11.6853 | 16 | 86 |
| age ² | 136.5531 | 151.5436 | 0.2403 | 2071.1 |
| d_disabled | 0.0469 | 0.2115 | 0 | 1 |
| d_fulltime | 0.7579 | 0.4283 | 0 | 1 |
| d_parttime | 0.1571 | 0.3639 | 0 | 1 |
| d_training | 0.0459 | 0.2092 | 0 | 1 |
| d_marginal | 0.0381 | 0.1914 | 0 | 1 |
| d_sheltered | 0.0010 | 0.0312 | 0 | 1 |
| Education dummies | | | | |
| 1a inadeq. compl. | 0.0287 | 0.1669 | 0 | 1 |
| 1b elementary | 0.0944 | 0.2924 | 0 | 1 |
| 1c basic voc. | 0.2689 | 0.4434 | 0 | 1 |
| 2b middle gen. | 0.0429 | 0.2027 | 0 | 1 |
| 2a middle voc. | 0.2698 | 0.4439 | 0 | 1 |
| 2c_gen: hi gen. | 0.0246 | 0.1548 | 0 | 1 |
| 2c_voc: hi voc. | 0.0649 | 0.2464 | 0 | 1 |
| 3a low tert. | 0.0575 | 0.2328 | 0 | 1 |
| 3b high tert. | 0.1483 | 0.3554 | 0 | 1 |
| d_single | 0.2550 | 0.4358 | 0 | 1 |
| d_married | 0.6383 | 0.4805 | 0 | 1 |
| d_separated | 0.0200 | 0.1398 | 0 | 1 |
| d_divorced | 0.0703 | 0.2557 | 0 | 1 |
| d_widowed | 0.0141 | 0.1181 | 0 | 1 |
| Number of Persons in HH | 3.0280 | 1.3128 | 1 | 17 |
| d_German | 0.8734 | 0.3326 | 0 | 1 |
| d_EastGermany | 0.1992 | 0.3994 | 0 | 1 |
| Observations | 203816 | | | |

Apart from these variables that generally describe an individual's life, we also focus on more directly workplace related variables, namely the autonomy associated with an individual's occupation as well as number of hours worked in the job. The autonomy variable in the SOEP dataset distinguishes autonomy levels *inter alia* based on task descriptions, vocational training, responsibilities and company size for civil servants, workers and employees and the self-employed. It distinguishes five regular autonomy levels plus the lowest level of apprenticeship (encompassing interns and trainees). Low autonomy levels are related to manual workers, whereas manager and freelance academics are in the highest autonomy level group. Self-employed individuals are categorized into autonomy levels 3 to 5 depending on their number of employees.

A final main variable is an individual's worries, which is a composite measure computed via principal component analysis. It consists of a number of more specific worries, namely the extent to which an individual worries about economic development, finances, environment, peace and job security. These represent an individual's perceptions of life and may contrast with that individual's objective living conditions. They reflect both selfish (job, economic conditions) and more altruistic worries (world peace and the environment) and are originally assessed on a Likert scale from 1 ("very concerned") to 3 ("not concerned at all"). This worries variable can be seen as a crude proxy of some aspects of personality (worries actually capture more than, for example, just the neurotic attitudes of the individual, see [Binder and Ward, 2013](#)).¹

Apart from these main variables, we also include some typical control variables (see Table 1) such as gender, age, age², regions (German "Bundeslaender" and East vs. West-Germany) and an individual's highest level of education, as measured by the CASMIN scale. This is measured ordinally, ranging from zero ("In School") to nine ("Higher Tertiary Education"). Our interest in job-related factors leads us to drop unemployed individuals. Control variables are not reported to conserve space. The main variables are standardized to allow comparison of effect magnitudes across our sample. Table 2 contains the correlation matrix.

¹While personality often tends to be seen as something fixed, there has been recent evidence for the variability of personality ([Boyce et al., 2013](#)).

Table 2: Correlation matrix. Correlations significant at the 1% level indicated with stars.

| | lifesat | worksat | healthprob | log_inc | hoursworked | autonomy | worriesall |
|-------------|----------|----------|------------|----------|-------------|----------|------------|
| lifesat | 1 | | | | | | |
| worksat | 0.2308* | 1 | | | | | |
| healthprob | -0.1486* | -0.1576* | 1 | | | | |
| log_inc | 0.0209* | 0.0084* | -0.0121* | 1 | | | |
| hoursworked | 0.0061 | 0.0096* | -0.0076* | 0.0324* | 1 | | |
| autonomy | 0.0178* | 0.0297* | -0.0049 | 0.0186* | 0.0375* | 1 | |
| worriesall | -0.1093* | -0.0936* | 0.0397* | -0.0165* | -0.0013 | -0.0140* | 1 |

3. Methodology

We focus on how changes in our main variables are associated with changes of other main variables over time. Treating several variables as mutually endogenous, VARs allow us to uncover multiple potential channels of intertemporal association between these variables.

To start, we pre-process our VAR series $W_{i,t}$ to remove the influence of the following control variables $X_{i,t}$: education dummies; gender dummy; German nationality; age and age-squared; East Germany dummy; Bundeslaender (regional) dummies; dummies for separated, single, divorced, widowed, spouse being away in a different country; year dummies, and dummies for each integer of household size (equal to 5 if 5 or more in the household). i and t are individual and year indices respectively.

$$W_{i,t} = a + b \cdot X_{i,t} + w_{i,t}, \quad (1)$$

For the reduced-form VAR, estimated using Least Absolute Deviation (a.k.a. median regression), our regression equation takes the following simple form:

$$w_{i,t} = a + \sum_{\tau=t-s}^{t-1} \beta_{i,\tau} w_{i,\tau} + \varepsilon_{i,t}, \quad (2)$$

where $w_{i,t}$ is a $m \times 1$ vector containing the endogenous variables ($t-s$ refers to the number of lags examined). a is a constant and β is a $m \times m$ matrix containing the VAR coefficients. $\varepsilon_{i,t}$ the residual error term. In our application $m=7$.

To estimate our SVAR, we allow for instantaneous (acyclic) causal effects such that the vector $w_{i,t} = f(w_{i,t})$. Our regression equation is:

$$w_{i,t} = B \cdot w_{i,t} + \sum_{\tau=t-s}^{t-1} \gamma_{i,\tau} w_{i,\tau} + \epsilon_{i,t}, \quad (3)$$

A key step is identifying the matrix B . This is done using the algorithm in [Moneta et al. \(2013\)](#), which applies Independent Component Analysis (ICA) to recover the latent components that are fully statistically independent, before they are arranged in a causal ordering that best fits the data. We begin by estimating a reduced-form VAR to obtain the residuals $\hat{\varepsilon}_{i,t}$, then apply ICA to decompose the residuals into statistically independent

shocks $\hat{\epsilon}_t$. Then, the rows are permuted to obtain an estimate of a lower-triangular matrix with zeroes along the diagonal. Further details are in [Moneta et al. \(2013\)](#).

4. Results

We present two sets of results, namely the reduced-form panel VAR model (see [Table 3](#)) and, more importantly, the structural VAR model (see [Table 4](#)). For space reasons, we focus on commenting the structural VAR model (in particular, on the instantaneous effects), and leave the reduced-form panel VAR model untouched, noting the similarity in results.

To test whether the VAR-LiNGAM approach is valid, we require that the SVAR residuals are non-Gaussian. To investigate this, we run normality tests on the VAR residuals, and observe that the Shapiro-Wilk and Shapiro-Francia p -values are all smaller than 10^{-15} .

The primary causal factor is autonomy, which affects every other SVAR variable within the period (although we find no significant effect on health problems): it has direct positive effects on life and work satisfaction, (log) income and hours worked, and a negative direct effect on our worries variable (i.e. decreasing one's worries). Workplace autonomy has been conjectured to explain work satisfaction of the self-employed ([Benz and Frey, 2008](#); [Binder and Coad, 2013a,c](#)) and seems to be also relevant in explaining why work satisfaction is higher in smaller companies ([Benz and Frey, 2008](#))². Overall, we can show that this extends to life satisfaction more generally, positive effects of autonomy are thus not limited to workplace well-being.

Our causal ordering suggests that the second most important influence in our SVAR is the number of hours worked, which has causal effects on the remaining variables, although not all effects are significant. Hours worked has a positive effect on work satisfaction (and a non-significant effect on life satisfaction)³, as well as a positive effect on income. It is interesting to note that we find the causal arrow runs from hours worked to work satisfaction and not vice versa. Working more hours thus contributes to higher work satisfaction (cf. [Block and Koellinger, 2009](#), p204). This could be explained with reference to part-time employment

²See, however, [Binder and Coad \(2013a\)](#), who find that autonomy increases work and life satisfaction, as does company size. Whether company is thus a good proxy for autonomy is not yet settled.

³[Meier and Stutzer \(2008\)](#) report an inversely u-shaped effect of hours worked on life satisfaction for their SOEP sample.

Table 3: Reduced-form vector autoregression results, LAD estimation. 2-lag model with 79,152 observations. Constant term included in the regressions but not reported here. Key to significance levels: ** $p < 0.01$, * $p < 0.05$, * $p < 0.1$.

| | First lag | | | | | | | | | | |
|------------------|-------------------------|-------------------------|--------------------------|--------------------------|--------------------------|---------------------------|--------------------------|--------|--|--|-----------------------|
| | l_lifesat | l_worksat | l_hlthprob | l_log_inc | l_hrsworked | l_autonomy | l_worries | | | | |
| lifesat | -0.530*** (0.00257) | 0.0176*** (0.00254) | -0.00597** (0.00244) | 0.00188 (0.00249) | -0.00551** (0.00252) | 0.00194 (0.00239) | -0.00575** (0.00245) | - | | | - |
| worksat | 0.0150*** (0.00201) | -0.495*** (0.00199) | 0.000292 (0.00191) | 0.00239 (0.00195) | -0.00610*** (0.00197) | -0.00197 (0.00187) | -0.00685*** (0.00191) | - | | | - |
| hlthprob | -0.0169*** (0.00337) | -0.00158 (0.00334) | -0.538*** (0.00320) | 0.000218 (0.00327) | 0.00376 (0.00331) | 0.00179 (0.00314) | -0.00197 (0.00321) | - | | | - |
| log_inc | 0.00927*** (0.00233) | 0.00788*** (0.00231) | -0.00396* (0.00221) | -0.267*** (0.00226) | 0.0191*** (0.00229) | 0.0218*** (0.00217) | -0.00226 (0.00222) | - | | | - |
| hrsworked | -0.000725 (0.00142) | 0.00202 (0.00141) | -0.00291** (0.00135) | 0.00468*** (0.00138) | -0.348*** (0.00140) | 0.00794*** (0.00133) | -0.00164 (0.00136) | - | | | - |
| autonomy | 0.000357 (0.000553) | -0.000538 (0.000548) | -0.000899* (0.000526) | 0.00494*** (0.000536) | 0.00144*** (0.000543) | -0.00574*** (0.000516) | 0.000260 (0.000527) | - | | | - |
| worries | -0.00767* (0.00414) | -0.0128*** (0.00410) | -0.00254 (0.00394) | 0.00525 (0.00402) | -0.00529 (0.00407) | -0.00215 (0.00386) | -0.553*** (0.00395) | - | | | - |
| | Second lag | | | | | | | | | | Pseudo-R ² |
| | l2_lifesat | l2_worksat | l2_hlthprob | l2_log_inc | l2_hrsworked | l2_autonomy | l2_worries | | | | |
| lifesat | -0.234*** (0.00254) | 0.00953*** (0.00251) | -0.00568** (0.00242) | -0.00425* (0.00232) | -0.00235 (0.00245) | -0.00203 (0.00233) | -0.0124*** (0.00241) | 0.0945 | | | 0.0945 |
| worksat | 0.0111*** (0.00199) | -0.213*** (0.00196) | -0.00206 (0.00190) | -0.00255 (0.00182) | -0.00734*** (0.00192) | -0.00269 (0.00182) | -0.00840*** (0.00188) | 0.0766 | | | 0.0766 |
| hlthprob | -0.00831** (0.00333) | -0.00266 (0.00329) | -0.256*** (0.00318) | 0.00547* (0.00305) | 0.00701** (0.00321) | 0.000522 (0.00306) | -0.00246 (0.00316) | 0.1181 | | | 0.1181 |
| log_inc | 0.00604*** (0.00230) | 0.00813*** (0.00228) | -0.00156 (0.00220) | -0.0856*** (0.00210) | 0.0178*** (0.00222) | 0.0131*** (0.00211) | -0.000868 (0.00218) | 0.0418 | | | 0.0418 |
| hrsworked | -0.000779 (0.00141) | 0.00486*** (0.00139) | -0.00224* (0.00134) | 0.00324** (0.00129) | -0.112*** (0.00136) | 0.00466*** (0.00129) | -0.000362 (0.00133) | 0.0502 | | | 0.0502 |
| autonomy | -0.000489 (0.000547) | -0.000764 (0.000541) | -0.00113** (0.000522) | 0.00277*** (0.000500) | 0.000855 (0.000527) | -0.0171*** (0.000501) | 0.000544 (0.000518) | 0.0073 | | | 0.0073 |
| worries | -0.00183 (0.00409) | -0.0130*** (0.00405) | 0.00166 (0.00391) | 0.00257 (0.00374) | -0.00350 (0.00395) | -0.00462 (0.00376) | -0.245*** (0.00388) | 0.1325 | | | 0.1325 |

or working fewer hours mostly signal precarious employment which is not as conducive to work place well-being as a full-time job (the evidence on this is scarce and for UK data, [Bardasi and Francesconi, 2004](#), cannot find negative effects of atypical employment on work satisfaction).

Higher work satisfaction has positive effects on life satisfaction (which might be explained by a bottom-up view of well-being, where individual domain satisfactions add up to overall satisfaction with life) and positive effects on income. We interpret this to mean that individuals who are satisfied with their job are more productive within their company and earn higher incomes through promotions ([Graham et al., 2004](#)). The productivity-enhancing effect of work satisfaction is not limited to income though, but extends beyond workplace benefits: higher work satisfaction has a significant negative impact on health problems and worries. Being in a satisfying job is beneficial thus for physical and mental health of the worker alike.

It is interesting to note that the causal impact of health problems in our working populace is limited to increasing one's worries and decreasing life satisfaction. It is well known in the literature that bad health impacts negatively on subjective well-being ([Graham et al., 2011](#); [Binder and Coad, 2013b](#)). But finding no impact on income or the job more broadly might be driven by our focus on individuals who are holding a job, thus limiting the effect of health problems on the comparatively more healthy (individuals with severe health problems dropping out of the working populace are not part of our sample).

Life satisfaction has few causal effects in our analysis and is at the end of the causal ordering. It only affects worries negatively, as one would probably expect. At first glance, this runs counter to other studies that have found positive effects of life satisfaction on other life domains, showing that happier individuals tend to perform better in many respects such as income, health and job success ([Graham et al., 2004](#); [Lyubomirsky et al., 2005](#); [Binder and Coad, 2010](#)). However, if we look additionally at the first lag effects here, we find such positive causal effects of life satisfaction (it positively influences work satisfaction and income and decreases health problems). Considering both instantaneous and lagged effects, our causal results are thus extremely consistent with previous work on reduced-form vector-autoregressions in this area ([Binder and Coad, 2010](#); [Binder and Ward, 2013](#)). Being happier thus increases productivity but it does so over time and probably less directly than the

instantaneous relationships we observe in our SVAR.

Finally note that the worries variable has no causal effects on the other variables, when we consider instantaneous effects. However, it has a negative significant effect on subsequent work satisfaction when we look at the first lag. Since the worries variable includes aspects of the respondents' jobs, this result might stem from changes in objective working conditions (job security and finances) which prompt the individual to worry over one's job and hence decrease work satisfaction with a lag.

5. Conclusion

We analyzed causal linkages between well-being, income, health problems, worries, autonomy and hours worked in the job for working German individuals from 1984-2008 using a structural vector autoregression approach. Our most striking finding is the key role that workplace autonomy plays with respect to other variables. Given that autonomy and hours worked are the key causal drivers, it seems that individuals first choose their career trajectory in terms of autonomy or personal freedom, then decide how much to work (intensity down this trajectory), and well-being (work satisfaction and life satisfaction) is not something to be maximized as much as a residual that is enjoyed through choosing a job with the requisite workplace characteristics. Given autonomy's positive effect on life and work satisfaction as well as on worries, we note that any workplace-related policies that aim at improving worker's well-being should be aware that policy measures that try to further well-being at the expense of autonomy are likely to fail. To improve worker well-being, our results suggest taking an indirect route through improving the autonomy individuals enjoy at work.

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Table 4: SVAR results: instantaneous effects as well as the first lag. A second lag is included in the estimations but not reported here. Coefficients significant at the 1% level appear in bold. NB: the matrix of instantaneous effects appears about half-empty because it should form a lower-triangular matrix after appropriate row-permutations (reflecting the acyclic causal structure).

| | instantaneous effects | | | | | | | | | | first lag | | | | | | | | | | |
|-----------|-----------------------|----------------|----------------|----------------|---------------|----------------|-----------|----------------|----------------|----------------|---------------|----------------|----------------|----------------|------------|------------|-----------|----------------|----------------|-------------|------------|
| | lifesat | l_worksat | l_health | l_log_inc | l_hrsworked | l_autonomy | l_worries | l2_lifesat | l2_worksat | l2_health | l2_log_inc | l2_hrsworked | l2_autonomy | l2_worries | l2_lifesat | l2_worksat | l2_health | l2_log_inc | l2_hrsworked | l2_autonomy | l2_worries |
| lifesat | 0 | 0.2156 | -0.1214 | 0.0305 | -0.0030 | 0.0090 | 0 | -0.4253 | 0.0941 | -0.0592 | 0.0096 | -0.0041 | 0.0019 | -0.0027 | 0.0059 | 0.0031 | 0.0029 | 0.0028 | 0.0022 | 0.0022 | 0.0021 |
| worksat | 0 | 0 | 0 | 0 | 0.0102 | 0.0309 | 0 | 0.0114 | -0.3847 | -0.0006 | 0.0019 | -0.0035 | -0.0026 | -0.0063 | 0.0028 | 0.0028 | 0.0024 | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| hlthprob | 0 | -0.1678 | 0 | 0 | -0.0029 | 0.0035 | 0 | -0.0104 | 0.0059 | 0.0024 | 0.0016 | 0.0024 | 0.0025 | -0.0046 | 0.0028 | 0.0033 | 0.0033 | 0.0028 | 0.0025 | 0.0025 | 0.0015 |
| log_inc | 0 | 0.0128 | -0.0080 | 0 | 0.0038 | 0.0029 | 0 | 0.0033 | -0.0677 | -0.4435 | 0.0002 | 0.0029 | 0.0028 | 0.0027 | 0.0034 | 0.0034 | 0.0030 | -0.2209 | 0.0028 | 0.0028 | 0.0027 |
| hrsworked | 0 | 0.0034 | 0.0035 | 0 | 0.0406 | 0.0214 | 0 | 0.0080 | 0.0119 | -0.0061 | 0.0240 | 0.0027 | 0.0198 | 0.0032 | 0.0020 | 0.0031 | 0.0029 | 0.0042 | 0.0028 | 0.0028 | 0.0021 |
| autonomy | 0 | 0 | 0 | 0 | 0 | 0.0440 | 0 | -0.0006 | 0.0024 | -0.0015 | 0.0025 | -0.2391 | 0.0084 | 0.0037 | 0.0013 | 0.0016 | 0.0012 | 0.0076 | 0.0012 | 0.0012 | 0.0010 |
| worries | -0.0932 | 0 | 0 | -0.0194 | 0 | 0 | 0 | 0.0001 | -0.0001 | -0.0010 | 0.0039 | 0.0009 | -0.0388 | 0.0002 | 0.0005 | 0.0004 | 0.0003 | 0.0004 | -0.0388 | 0.0002 | 0.0005 |
| | 0.0031 | 0.0038 | 0.0030 | 0.0029 | 0.0034 | -0.0117 | 0 | -0.0446 | -0.0409 | 0.0016 | -0.0021 | -0.0076 | -0.0035 | 0.0010 | 0.0034 | 0.0036 | 0.0032 | 0.0039 | -0.0035 | -0.0035 | 0.0043 |