# QUANT EXAMPLE ANALYSIS

*This example does not include background/introduction sections, theoretical support for hypotheses, discussion of findings, limitations, future research directions, conclusions, etc. This is just an example of how one might slice up the analysis and report and interpret the findings.*

## Data Screening

**Univariate:**

- *Missing Data:*
  - RD1 had one missing value, which we imputed with the median. We used median imputation because RD1 is an ordinal variable (was measured using a Likert scale).
  - Two controls had missing values—representing 5% or less of the sample size, so we imputed the missing values for these continuous (scale) variables (income – 2 missing; and customer interactions – 16 missing) using the mean of all available values.
- *Outliers:*
  - All variables but one (customer interactions) were on ordinal scales with seven or fewer intervals, thus extreme value outliers do not exist. For customer interactions, we examined a box plot for outliers and found two respondents with exceptionally high values, however, we had no reason to believe these were incorrect values, and we have no theoretical basis for removing them. Thus they remain simply as high responses.
- *Normality*
  - Once again, since nearly all our variables are based on Likert-type scales, we have no reason to exclude variables based on skewness unless they exhibit no variance. Thus rather than testing skewness, we focused on kurtosis. Kurtosis greater than or less than +/- 1.00 indicates potentially problematic kurtosis (and therefore, lack of sufficient variance). All of the burnout from management items had borderline kurtosis issues (abs value between 1 and 2). These are fairly borderline values and we will simply flag them for potential future issues in subsequent analyses. BC3 and BC4 however, had kurtosis values around 3.0; therefore there is insufficient variance in those items to retain them. Accordingly, we have dropped those two items.

**Multivariate (tested after measurement model):**

- *Linearity*
  - We tested linearity by performing curve estimation regression for all direct effects in our model. The results show that the relationships between variables are sufficiently linear (i.e., all p-values were less than 0.05), except between Autonomy and Productivity; however, no curve estimation was significant either. Accordingly, we have left the relationship in our model, subject to trimming during subsequent analyses.
- *Homoscedasticity*
  - The results of the homoscedasticity test (scatter plot of zPred on zResid) indicate that the mediators and SatW are homoscedastic, but Reliability is slightly more heteroskedastic. As we will be moderating by gender and job category, we retested reliability for each subgroup (male, female, csr, bcr) and found it to be homoscedastic within each.
- *Multicollinearity*
  - We tested the Variable Inflation Factor for all of the exogenous variables simultaneously. The VIFs were all less than 2.0, indicating that the exogenous variables are all distinct. (If

you find that they are not all within a good range, you can cite O'Brian 2007 who says that high VIFs aren't necessarily a cause of alarm.)

**Exploratory Factor Analysis**

We conducted an EFA using Maximum Likelihood[1] with Promax rotation[2] to see if the observed variables loaded together as expected, were adequately correlated, and met criteria of reliability and validity. We address each of these below for the final seven-factor model depicted in the pattern matrix below:

- *Adequacy:*
  - The KMO and Bartlett's test for sampling adequacy was significant and the communalities for each variable were sufficiently high (all above 0.300 and most above 0.600), thus indicating the chosen variables were adequately correlated for a factor analysis. Additionally, the reproduced matrix had only 2% non-redundant residuals greater than 0.05, further confirming the adequacy of the variables and 7-factor model. (If individual items have low communalities (like less than 0.200), you might do yourself a favor by removing them. These items are probably the ones that also had kurtosis issues.)
- *Reliability:*
  - The Cronbach's alphas for the extracted factors are shown below, along with their labels and specification. All alpha's were above 0.70 except Unsupportive Coworkers which was very close at 0.691. The factors are all reflective because their indicators are highly correlated and are largely interchangeable (Jarvis et al. 2003).

| Factor Label | Cronbach's alpha | Specification |
|---|---|---|
| Feedback | 0.907 | Reflective |
| Reliability | 0.795 | Reflective |
| Resource Demand Gap | 0.800 | Reflective |
| Learning Orientation | 0.875 | Reflective |
| Autonomy | 0.864 | Reflective |
| Unsupportive coworkers | 0.691 | Reflective |
| Satisfaction with work | 0.774 | Reflective |

[1] Maximum Likelihood Estimation was chosen in order to determine unique variance among items and the correlation between factors, and also to remain consistent with our subsequent CFA. Maximum Likelihood also provides a goodness of fit test for the factor solution.

[2] Promax was chosen because the dataset is quite large (n=304) and promax can account for the correlated factors.

- *Validity:*
  - The factors demonstrate sufficient convergent validity, as their loadings were all above the recommended minimum threshold of 0.350 for a samples size of 300 (Hair et al., 2010). The factors also demonstrate sufficient discriminant validity, as the correlation matrix shows no correlations above 0.700, and there are no problematic cross-loadings.

**Pattern Matrix[a]**

| | Factor | | | | | | |
|---|---|---|---|---|---|---|---|
| | FB | RL | RD | LO | AU | UC | SW |
| f1 | .884 | | | | | | |
| f2 | .881 | | | | | | |
| f3 | .861 | | | | | | |
| f4 | .734 | | | | | | |
| q2 | | .806 | | | | | |
| q5 | | .754 | | | | | |
| q1 | | .712 | | | | | |
| q4 | | .597 | | | | | |
| q3 | | .547 | | | | | |
| rd3 | | | .895 | | | | |
| rd4 | | | .741 | | | | |
| rd2 | | | .698 | | | | |
| rd1 | | | .601 | | | | |
| l3 | | | | .894 | | | |
| l1 | | | | .831 | | | |
| l2 | | | | .806 | | | |
| a1 | | | | | .897 | | |
| a2 | | | | | .844 | | |
| a3 | | | | | .753 | | |
| uc2 | | | | | | .830 | |
| uc1 | | | | | | .633 | |
| uc3 | | | | | | .528 | |
| sw1 | | | | | | | .908 |
| sw3 | | | | | | | .609 |
| sw2 | | | | | | | .472 |

Extraction Method: Maximum Likelihood Estimation.

Rotation Method: Promax with Kaiser Normalization.

This seven-factor model had a total variance explained of 60%, with all extracted factors having eigenvalues above 1.0 except one, which was close at 0.989.

**Confirmatory Factor Analysis**

- *Model Fit*
    - We removed RD3 due to poor loading. UC3 also was somewhat low (0.58); however, we did not remove it because the factor only had three indicators, and a two-indicator factor often results in instability. Modification indices were consulted to determine if there was opportunity to improve the model. Accordingly, we covaried the error terms between f3 and f4. The table below indicates that the goodness of fit for our measurement model is sufficient.

| Metric | Observed value | Recommended |
|---|---|---|
| cmin/df | 1.508 | Between 1 and 3 |
| CFI | 0.965 | >0.950 |
| RMSEA | 0.041 | <0.060 |
| PCLOSE | 0.959 | >0.050 |
| SRMR | 0.051 | <0.090 |

- *Validity and Reliability*
    - To test for convergent validity we calculated the AVE. For all factors, the AVE was above 0.50 except for Unsupportive Coworkers, which was close at 0.460. However, as this factor is minimally correlated with the other factors in the model, and because the reliability score (0.716) was greater than 0.700, we felt this was admissible ( i.e., while it is not especially strong internally, it is, at least, a reliable and distinct construct within our model).
    - To test for discriminant validity we compared the square root of the AVE (on the diagonal in the matrix below) to all inter-factor correlations. All factors demonstrated adequate discriminant validity because the diagonal values are greater than the correlations.
    - We also computed the composite reliability for each factor. In all cases the CR was above the minimum threshold of 0.70, indicating we have reliability in our factors. (If you experience problems during this phase with AVE or CR, it is probably because you did not have a good EFA solution. I would return to the EFA to work that out first.)

| | CR | AVE | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|
| **1. LearningO** | 0.876 | 0.703 | **0.838** | | | | | | |
| **2. Feedback** | 0.900 | 0.693 | 0.197 | **0.833** | | | | | |
| **3. Reliability** | 0.804 | 0.509 | 0.227 | 0.007 | **0.713** | | | | |
| **4. RDGap** | 0.805 | 0.510 | -0.180 | -0.402 | 0.021 | **0.714** | | | |
| **5. UnsCoW** | 0.716 | 0.460 | -0.252 | -0.391 | -0.008 | 0.316 | **0.678** | | |
| **6. Autonomy** | 0.865 | 0.680 | 0.338 | 0.384 | -0.142 | -0.425 | -0.399 | **0.825** | |
| **7. SatW** | 0.772 | 0.533 | 0.486 | 0.377 | -0.092 | -0.575 | -0.470 | 0.625 | **0.730** |

- *Common Method Bias*
    - Because the data for both IVs and DVs was collected using a single instrument (a survey), we conducted a common method bias test to determine if a method bias was affecting the results of our measurement model. The test we used was the "unmeasured latent factor" method recommended by Podsakoff et al. (2003) for studies that do not explicitly measure a common factor (as in this study). Comparing the standardized regression weights before and after adding the Common Latent Factor (CLF) shows that none of the regression weights are dramatically affected by the CLF—i.e., the deltas are less than 0.200 and the CR and AVE for each construct still meet minimum thresholds. Nevertheless, to err on the conservative side, we have opted to retain the CLF for our structural model (by imputing composites in AMOS while the CLF is present), and thus we have CMB-adjusted values. (Retaining the CLF is not required if you find no CMB.)
- *Invariance Tests*
    - Since we are planning on moderating the structural model with two categorical variables, we conducted configural and metric invariance tests.
    - Gender:
        - The model fit of the unconstrained measurement models (with groups loaded separately) had adequate fit (cmin/df = 1.423; CFI 0.942), indicating that the model is configurally invariant. After constraining the models to be equal, we found the chi-square difference test to be non-significant (pval>0.05); thus, our measurement model meets criteria for metric invariance across gender as well.
        - **[note to students]** Had it not met the criteria for metric invariance, you would need to look at the differences between regression weights for the two groups to see which regression weight was most different. This might then need to be removed if possible. If not possible, you might rely on MacKenzie et al. 2011 "Construct Measurement and Validation Procedures in MIS and Behavioral

Research: Integrating New and Existing Techniques", who say that as long as one item per construct (aside from the constrained one) is metrically invariant, then you can proceed with further invariance tests (like multi-group moderation). You can test this using the critical ratios approach described in the video called: "multigroup moderation in amos – made easy".

- Job category
  - The model fit for job category was equally good (cmin/df = 1.356; CFI 0.952). The chi-square difference test was again non-significant (pval>0.05).

**Hypotheses**

All hypotheses were tested while controlling for Education, Income, and Number of customers handled per day. Mediation tests were conducted without the presence of moderators. Multi-group moderation tests were conducted using the full model, but prior to adding the interaction variables. Interaction effects were tested using the full dataset, rather than the moderated dataset. These procedures were necessary in order to have enough power to test each set of hypotheses, and in order to maintain theoretical clarity and parsimony.

**[note to students]** You would of course also provide here some theoretical logic for why you included the controls you included and for why you expect the hypothesized relationships to be observed as hypothesized.

*Mediation*

H1a. Learning Orientation mediates the negative relationship between Resources demand gap and Satisfaction with work.

H1b. Learning Orientation mediates the negative relationship between Resources demand gap and Reliability.

*Multi-group moderation*

H2a. The positive relationship between Autonomy and Satisfaction with work will be stronger for males than for females.

H2b. The positive relationship between Autonomy and Reliability will be stronger for males than for females.

*Interaction*

H3a. An increase in Unsupportive Coworkers will *strengthen* the negative relationship between Resource Demand Gap and Learning Orientation.

H3b. An increase in Unsupportive Coworkers will *weaken* the positive relationship between Feedback and Learning Orientation.

**Structural Model**

- *Create Composites from factor scores*
  - Composite variables were created using factor scores in AMOS while the CLF was present. (This is not necessary, but optional. You may retain the full structural model if you desire – it just gets a bit unwieldy with interactions.)
  - Interaction terms were created by standardizing the appropriate variables, and then multiplying them.
- *Model Fit (of initial structural model after fitting – i.e., not during moderation tests).*
  - The fitted structural model demonstrates adequate fit. In order to achieve good fit, we were required to add a direct path between resource demand gap and satisfaction with work, as well as between unsupportive coworkers and satisfaction with work. We felt these additions were theoretically logical, and probably indicate that the hypothesized mediation is actually partial rather than full. We additionally covaried the error terms of the mediators, as we wanted to account for their correlation without adding theoretical complexity to our model. To remain consistent,[3] we covaried the error terms of the dependent variables. While there may exist causal relationships between these variables, this is not the focus of this model. The actions we have taken allow us to account for these potential correlations without having to explicitly theorize and test them.

| Metric | Observed value | Recommended |
|---|---|---|
| cmin/df | 1.393 | Between 1 and 3 |
| CFI | 0.965 | >0.950 |
| RMSEA | 0.041 | <0.060 |
| PCLOSE | 0.959 | >0.050 |
| SRMR | 0.0396 | <0.090 |

- *Controls*
  - The controls did not have a significant impact on either dependent variable, except the number of customers handled per day had a slight negative effect on Satisfaction with work (standardized beta = -0.061*).

[3] This issue of consistently applying theoretical reasoning when covarying error terms is advocated by David Kenny: http://davidakenny.net/cm/respec.htm. He also recommends this action be considered especially when the modification indices indicate that such an action would significantly reduce the chi-square. This second criteria was also true for this model.

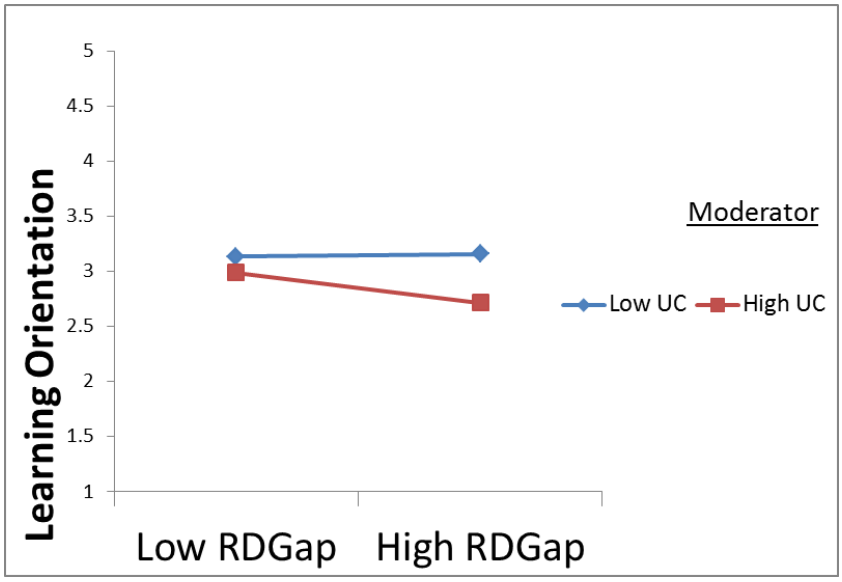
- *Hypothesis testing*
  - Mediation

    Mediation was tested using 2000 bias corrected bootstrapping resamples in AMOS. The direct and indirect effects were analyzed for potential partial mediation (discovered while fitting the model). Just indirect effects were analyzed for establishing full mediation. The results are summarized in the Hypotheses Summary table below.

    **[note to students]** In addition to bootstrapping, you may want to follow the Baron and Kenny approach (direct effects tested, then add mediator, then see if direct effects drop).
  - Multi-group Moderation

    To test the categorical moderation hypotheses, we produced the critical ratios for the differences in regression weights between groups. From these critical ratios we calculated p-values to determine the significance of the difference. The results are summarized in the Hypothesis Summary table below.
  - Interaction

    To test the interaction hypotheses we first standardized the IVs and then created product variables. We then trimmed non-significant interaction regressions one at a time until only significant paths remained. In this case, only one significant path remained, from RDxUC to LO. We plotted this interaction as shown below. The results of the interaction tests are summarized in the Hypothesis Summary table below. Additionally, we observed that model fit was good (cmin/df = 1.644; CFI 0.981) for the final moderated model.



| Hypothesis Summary Table | | |
|---|---|---|
| ***Mediation*** | ***Evidence*** | ***Supported?*** |
| **H1a.** Learning Orientation mediates the negative relationship between Resources demand gap and Satisfaction with work. | Direct w/o Med: -.372***<br>Direct w/ Med:0.237***<br>Indirect: -.124*** | **Yes**:<br>Partial Mediation |
| **H1b.** Learning Orientation mediates the negative relationship between Resources demand gap and Reliability. | Direct w/o Med: -.182***<br>Direct w/ Med: 0.056(ns)<br>Indirect: -.088*** | **Yes**:<br>Full Mediation |
| ***Multi-group moderation*** | | |
| **H2a.** The positive relationship between Autonomy and Satisfaction with work will be stronger for males than for females. | Males: 0.486***<br>Females: 0.267***<br>ΔZscore: -2.62*** | **Yes**:<br>Stronger for males |
| **H2b.** The positive relationship between Autonomy and Reliability will be stronger for males than for females. | Males: -0.394***<br>Females: -0.274***<br>ΔZscore: 0.545(ns) | **No**:<br>No difference |
| ***Interaction*** | | |
| **H3a.** An increase in Unsupportive Coworkers will *strengthen* the negative relationship between Resource Demand Gap and Learning Orientation. | Interaction effect:<br>-0.074* | **Yes**:<br>Stronger negative effect |
| **H3b.** An increase in Unsupportive Coworkers will *weaken* the positive relationship between Feedback and Learning Orientation. | Interaction effect:<br>0.037(ns) | **No**:<br>No Effect |