Assignment 4 for 280A

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1&2. Write a paragraph that describes the robustness check

I re-estimate the ITT effects using standardized zzz-scores instead of the Item Response Theory (IRT) scores employed in the baseline analysis. While IRT scoring incorporates item difficulty and discrimination parameters, it also embeds modeling assumptions about the latent ability distribution. To verify that the main findings are not driven by the psychometric structure of the IRT model, I construct simple standardized scores using the control group's baseline mean and standard deviation:

$$Z_{is}^{t} = \frac{Y_{is}^{t} - \mu_{s,\text{control, baseline}}}{\sigma_{s,\text{control, baseline}}},$$

where Y_{is}^{t} is the raw IRT score for student i in subject s at time t. Using these alternative outcome measures, I re-estimate the ANCOVA specification:

$$Z_i^{\text{end}} = \alpha + \beta\,\text{Treat}_i + \gamma Z_i^{\text{base}} + \phi_{s(i)} + \varepsilon_i.$$

The resulting ITT estimates remain very similar to the IRT-based results for both math and Hindi. This confirms that the program's estimated impacts are not sensitive to the IRT scoring framework and are robust to alternative outcome normalization.

3. Code: include the output (next page)

3. Code

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[1]:
```python
import pandas as pd
import statsmodels.api as sm

# Load data
df = pd.read_stata("ms_blel_jpal_long.dta")

# Baseline rows
base = df[df["round"] == "Baseline"][[
    "st_id", "strata", "treat", "m_theta_mle", "h_theta_mle", "in_r2"
]].rename(columns={
    "m_theta_mle": "m_base",
    "h_theta_mle": "h_base",
    "in_r2": "in_r2_base"
})

# Endline rows
end = df[df["round"] == "Endline"][[
    "st_id", "m_theta_mle", "h_theta_mle", "in_r2"
]].rename(columns={
    "m_theta_mle": "m_end",
    "h_theta_mle": "h_end",
    "in_r2": "in_r2_end"
})

# Merge into wide format
wide = base.merge(end, on="st_id")

# Restrict to IRT linking sample
wide = wide[(wide["in_r2_base"] == 1) & (wide["in_r2_end"] == 1)]
```

[2]:
```python
# compute z-scores using control baseline mean & SD
control_base = wide[wide["treat"] == 0]

for subj in ["m_base", "m_end", "h_base", "h_end"]:
    mu = control_base[subj].mean()
    sd = control_base[subj].std()
    wide[subj + "_z"] = (wide[subj] - mu) / sd
```

[3]:
```python
def itt_reg(y_col, base_col):
    data = wide[[y_col, base_col, "treat", "strata"]].dropna().copy()

    X = data[["treat", base_col]]

    # strata fixed effects
    strata_dummies = pd.get_dummies(
        data["strata"].astype(int), prefix="strata", drop_first=True
    )
    X = pd.concat([X, strata_dummies], axis=1)

    X = sm.add_constant(X)
    y = data[y_col]

    model = sm.OLS(y, X).fit(cov_type="HC1")
    return model
```

[4]:
```python
mod_math_z = itt_reg("m_end_z", "m_base_z")
mod_hindi_z = itt_reg("h_end_z", "h_base_z")

print("Math ITT (Z-score):", mod_math_z.params["treat"])
print("Hindi ITT (Z-score):", mod_hindi_z.params["treat"])

print("\nFull results - Math Z:\n", mod_math_z.summary().tables[1])
print("\nFull results - Hindi Z:\n", mod_hindi_z.summary().tables[1])
```

```
Math ITT (Z-score): 0.40309093713149957
Hindi ITT (Z-score): 0.22601482229555897

Full results - Math Z:
 ==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.0479      0.205      0.234      0.815      -0.354       0.450
treat          0.4031      0.067      6.032      0.000       0.272       0.534
m_base_z       0.6333      0.044     14.505      0.000       0.548       0.719
strata_2       0.6124      0.339      1.806      0.071      -0.052       1.277
strata_3       0.1877      0.219      0.859      0.390      -0.241       0.616
strata_4       0.2328      0.282      0.824      0.410      -0.321       0.786
strata_5       0.1474      0.229      0.645      0.519      -0.301       0.596
strata_6       0.1982      0.296      0.670      0.503      -0.382       0.778
strata_7       0.4129      0.314      1.317      0.188      -0.202       1.027
strata_8       0.0670      0.310      0.216      0.829      -0.540       0.674
strata_9       0.3448      0.246      1.403      0.161      -0.137       0.826
strata_10      0.0110      0.322      0.034      0.973      -0.620       0.642
strata_11      0.0702      0.284      0.248      0.804      -0.486       0.626
strata_12     -0.1097      0.222     -0.495      0.621      -0.544       0.325
```

```
strata_13     -0.1475      0.221     -0.668      0.504      -0.580       0.285
strata_14     -0.0347      0.230     -0.151      0.880      -0.486       0.417
strata_15     -0.4067      0.258     -1.577      0.115      -0.912       0.099
strata_16     -0.0180      0.330     -0.055      0.956      -0.664       0.628
strata_17     -0.2768      0.229     -1.206      0.228      -0.727       0.173
strata_18     -0.5279      0.257     -2.052      0.040      -1.032      -0.024
strata_19     -0.2565      0.237     -1.083      0.279      -0.720       0.208
==============================================================================

Full results - Hindi Z:
 ==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const          0.3517      0.158      2.229      0.026       0.042       0.661
treat          0.2260      0.058      3.912      0.000       0.113       0.339
h_base_z       0.6666      0.036     18.406      0.000       0.596       0.738
strata_2       0.1616      0.179      0.901      0.367      -0.190       0.513
strata_3      -0.2063      0.166     -1.240      0.215      -0.532       0.120
strata_4      -0.0833      0.212     -0.392      0.695      -0.499       0.333
strata_5      -0.0428      0.179     -0.239      0.811      -0.394       0.309
strata_6      -0.0215      0.207     -0.104      0.917      -0.427       0.384
strata_7       0.0095      0.296      0.032      0.974      -0.570       0.589
strata_8      -0.3688      0.310     -1.191      0.233      -0.975       0.238
strata_9      -0.3465      0.257     -1.347      0.178      -0.851       0.158
strata_10     -0.6636      0.233     -2.852      0.004      -1.120      -0.208
strata_11     -0.3997      0.240     -1.665      0.096      -0.870       0.071
strata_12     -0.6152      0.188     -3.278      0.001      -0.983      -0.247
strata_13     -0.5314      0.183     -2.901      0.004      -0.890      -0.172
strata_14     -0.3025      0.172     -1.763      0.078      -0.639       0.034
strata_15     -0.7227      0.214     -3.373      0.001      -1.143      -0.303
strata_16     -0.2960      0.193     -1.530      0.126      -0.675       0.083
strata_17     -0.4562      0.176     -2.589      0.010      -0.802      -0.111
strata_18     -0.3854      0.259     -1.486      0.137      -0.894       0.123
strata_19     -0.4245      0.194     -2.184      0.029      -0.806      -0.044
==============================================================================

/opt/anaconda3/lib/python3.8/site-packages/statsmodels/tsa/tsatools.py:142:
FutureWarning: In a future version of pandas all arguments of concat except for
the argument 'objs' will be keyword-only
  x = pd.concat(x[::order], 1)
```

[ ]: