Agent-Based Simulations on Catalan Interprovincial Migrations

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Introduction

This work considers and substantiates some factors that influence human decision-making on migrating. So, the topic has assumptions related to demography, migration, and policies. These assumptions are summarized in the thesis in an indicative mathematical model. Then, these assumptions are studied empirically using a statistical model. The empirical findings are usable for solidifying a set of hypotheses of an Agent-Based Model in NetLogo.

The work's hypotheses are a simple set of logical assumptions on an individual's expected reactions toward economic incentives that fuel their migration decisions. After studying the hypotheses, the objective is to replicate the Catalan interprovincial migrations of the years 2008-2020 with Barcelona as the host.

Methodology

Initially, a database is created. Then, the database is used to create a theoretical econometric model of migration. The model's regressions are from RStudio. Next, the results of the econometric model are used to justify the hypotheses of the NetLogo model. Finally, after calibration, a NetLogo tool named Behaviorspace is used to generate the illustrated data in the next section. In short, RStudio is used for regressions and NetLogo for the Catalan interprovincial migrations simulations.

Results

OLS done via RStudio using 156 observations. The dependent variable is ProbMig.

$$\text{Log-Log Linear Model: } \ln(\text{ProbMig}) = \beta_0 - \beta_1 \cdot \ln(\text{oSali}) + \beta_2 \cdot \ln(\text{dSalj}) + \beta_3 \cdot \ln(\text{Stockij}) - \beta_4 \cdot \ln(\text{Distij}) - \beta_5 \cdot \ln(\text{oEmpl}) + \beta_6 \cdot \ln(\text{dEmpl}) - \beta_7 \cdot \ln(\text{oUnemp}) + \beta_8 \cdot \ln(\text{dUnemp})$$

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Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)    7.82840    5.87811   1.332   0.1850
log(oSal.i)   -7.84009    0.32391 -24.205  < 2e-16 ***
log(dSal.j)    6.81388    0.31795  21.431  < 2e-16 ***
log(Stock.ij)  0.47153    0.02403  19.626  < 2e-16 ***
log(Dist.ij)  -0.69257    0.06824 -10.149  < 2e-16 ***
log(oEmpl.)   -0.47741    0.60577  -0.788   0.4319
log(dEmpl.)    4.70864    0.60457   7.788 1.12e-12 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Multiple R-squared:  0.9742, Adjusted R-squared:  0.9728
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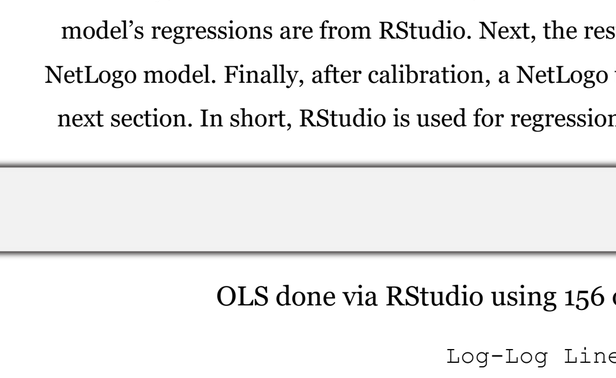
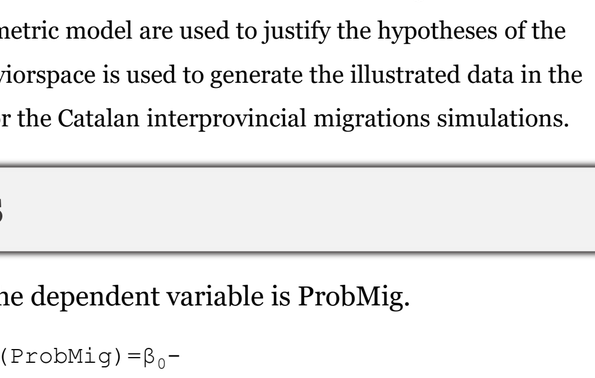
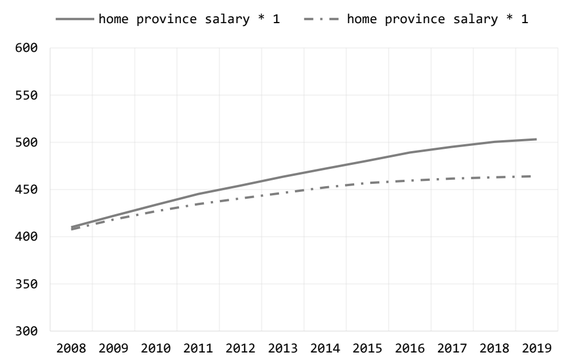


Proportion Migrating - Girona

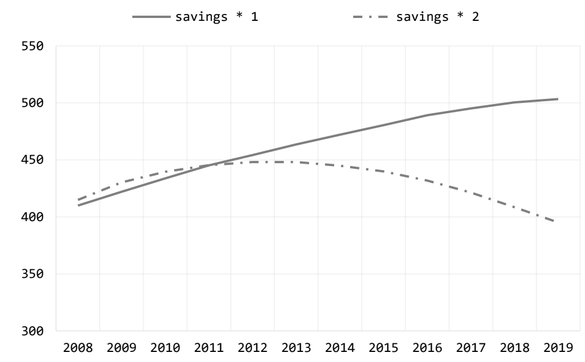


Proportion Returning - Girona

In the simulation graphs, the black line represents the mean of each type of simulation. The upper bounds of each graph represent the maximum reached among 99% of observations during each year of the simulations. The lower bounds represent the minimum of each year. The different colors classify the range under which are a certain percentage of observations.



Average migrant stock per year of 100 model runs at different values of home salary - Girona



Average migrant stock per year of 100 model runs at different values of savings - Girona

These graphs represent 100 simulations for each type of graph, where the first one shows the average stocks after an increase in average home salary against the calibrated model. The second one shows the average stocks after increments in the savings against the calibrated model.

Conclusions

The simulated NetLogo data adjust well into the range of the empirical data and follows the upward trend well up until the year 2015. Future study is necessary to fine-tune the models so these can adjust to the downward trends after the year 2016. Overall, the models do a good job and adjust well into the empirical data range.

The stock graphs show us that higher home salary prospects and higher savings indeed incentivize individuals in the model to move back and stay at home. The same is true for the opposite, which the non-altered figures reflect. We can appreciate that the number of migrants at host starts to decrease over time after an initial increase. This effect produces because the higher the savings are, the more are workers able to migrate, but later are incentivized to go back due to the much higher salaries at home.

An interesting thing about the model is its theoretical capacity to make predictions for the future. A robust model with this approach could help mold policy in real life to treat the main reasons for interprovincial migrations in the future.